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ARTHUR SCHOPENHAUER.

WHEN Arthur Schopenhauer published his chief work, "Die Welt als Wille und Vorstellung" (The World as Will and Idea), no one suspected that the book would continue to exert a powerful influence on the development of our conception of the world, and that the hundredth birthday of the author would be honored by all educated people. Only a few recognized the depth and creative power of the mind which spoke from this book, but among these few were Goethe and Jean Paul. The former referred to Schopenhauer in his "Tag- und Jahresheften" of 1819; and in his "Kleinen Nachschule zur Aesthetischen Vorschule," Jean Paul expressed the opinion that Schopenhauer's book had not received the praise it deserved, for it was a work of bold and original philosophy, full of penetration and deep thought. He said that he could praise it, but could not subscribe to its teachings on account of their "desolate and bottomless depth which might be compared to the melancholy lake in Norway, from which one who looks up between the high rocky walls which surround it can never see the sun, only the starry heavens appearing to him, and across which lake no bird or wave ever moves." It was principally this desolate and bottomless depth which dismayed the reader of Schopenhauer at that time, when the well constructed theory of Hegel was universally proclaimed as the best and most complete; and even to-day the most intelligent admirers and adherents of Schopenhauer can only praise, not accept, his philosophy.

The circumstances of Schopenhauer's life were most favorable for a philosopher. He received an excellent education, had an early opportunity of becoming acquainted with the principal seats of European culture—thus broadening his horizon—and then found himself a wealthy man, without any care as to the necessaries of life, and in a position to devote himself to science. He was the son of the respected merchant Heinrich Floris Schopenhauer and Johanna Schopenhauer, who was later so beloved as an authoress, and he was born on February 22, 1788, in Danzig. He spent only the first five years of his life there, as his parents, shortly before the taking of Danzig on March 28, 1793, fled to Hamburg, that they might continue to live in a free state. In Hamburg Arthur Schopenhauer soon gained the ordinary school knowledge under the direction of his intelligent mother; and in 1803 started with his parents on a journey which was very extensive for those times. First, Holland and the north of France were visited, then followed a longer sojourn in London and a trip through England and Scotland. After this they turned toward Paris, where they tarried several months, so that Mrs. Johanna Schopenhauer might realize a long cherished wish to learn miniature painting from the celebrated painter Augustin. Then they went to the south of France, to Switzerland, spent some time in Vienna, and finally passed through Silesia, Bohemia, and Saxony, reaching Hamburg again in 1806. Here the family met with a great misfortune; the merchant Schopenhauer, who had easily borne all the fatigue of the journey, was suddenly taken sick and died after a short illness. Mrs. Johanna Schopenhauer then left Hamburg and moved to Weimar with her son and her little daughter Adele, so as to lead a life of more active intellectual intercourse with the celebrated poets and savants of that place. Soon after their arrival the whole city was, unfortunately, thrown into a state of great confusion by the war which broke out between France and Prussia, and the advance of the French. Many of the inhabitants packed their valuables and fled, but Madam Schopenhauer did not allow her judgment to be affected by the universal confusion. She thought, with reason, that there would be far more danger in flight than in remaining where she was. She arranged everything in her house, and as both she and her son Arthur had perfect command of the French language, she was enabled to meet the conquerors of Jena, when they entered the city, in such a manner that she was not only spared all pillage, but could offer hospitality to many who were in trouble. For this reason friendly relations were all the more easily established when order was again restored. The Schopenhauer house soon became the center of a notable literary circle in which Goethe, Wieland, Bertuch, Falk, Heinrich Meyer, Fernow, and others moved, and by which many illustrious travelers were entertained.

This intellectual life had a favorable influence on young Arthur Schopenhauer; he was directed in the study of the natural sciences by Goethe, in art by Meyer, and studied Italian with Fernow. In 1809 he entered the University of Göttingen, where he gave himself up to the study of physics, mineralogy, and anatomy, and also attended the lectures of Prof. G. E. Schulze. Besides, by the advice of Prof. Schulze, he took up the philosophy of Plato and Kant, and he studied Aristotle and Spinoza. From these studies his development received a definite character which had an influence on his later researches. It was always evident that however broadly his studies extended, his thoughts dwelt principally on Kant and Plato.

After a two years' sojourn in Göttingen, Schopenhauer went to Berlin, in 1811, in order to hear Fichte, who was then in the zenith of his fame; but he could not reconcile himself to this idealism, and soon turned completely from it. To close his academic studies in Berlin, he wrote a thesis "Ueber die vierfache Wurzel des Satzes vom zureichenden Grunde" (On the Fourfold Route of the Principle of Sufficient Reason), hoping that it would help him to graduate as doctor of philosophy; but the war that now broke out prevented his graduation, which, however, took place later at Jena. Schopenhauer then spent some time in Weimar, where Goethe made him familiar with his own studies on colors, and the orientalist Friedrich Majer opened up to him the antiquities of India and instructed him in the sacred writings of the Hindoos. A partiality for the thought of the Orient, and an inclination toward the teachings of Buddha, was now developed in Schopenhauer, which gave a decided tinge to his subsequent writings.

After political conditions had become settled, Schopenhauer spent several years in Dresden, where he studied the art collections and devoted himself to the different sciences. But he was occupied chiefly with himself, and from this long process of meditation a system of philosophy was finally crystallized which he now unfolded in his work, "Die Welt als Wille und Vorstellung." After the completion of this work in 1818, he undertook a journey to Rome and Naples, and then in 1820 settled at the University of Berlin. He lectured only six months, however, when he returned to Italy, where he remained until 1825. At this time he went back to Berlin, but not as an instructor of philosophy; and when, in 1831, the cholera appeared in Berlin, he fled to Frankfurt a. Main, where he was so pleased with the situation of the city and with the climate that he decided to remain, and lived there until his death—September 20, 1860—isolated from the affairs of the world, in philosophic loneliness. During these thirty years his writings were limited to three works: "Ueber den Willen in der Natur" (The Will in Nature), which appeared in 1836, "Die Untersuchungen uber die bieden Grundprobleme der Ethik" (Researches in Regard to the Main Problems of Ethics), published in 1841, and the two volumes of philosophical essays which appeared in 1851 under the title "Parerga und Paralipomena." We find the cause of the limited number of his works in the fact that Schopenhauer's writings remained almost unnoticed for years, as we have said, which was a source of great affliction to the author. To-day, when pessimism has such a crowd of adherents, it seems almost incredible that only a small part of the first edition of Schopenhauer's chief work, "Die Welt als Wille und Vorstellung," was sold, most of it being used for waste paper, and that the second edition, which appeared twenty-five years later, had to be reduced in price after some years, so as to defray the expense of printing by obtaining a larger market. The attention of a larger circle was first directed to the Schopenhauer philosophy in 1853 by an article in the *Westminster Review*, and soon it gained many disciples, especially in Germany. In the last thirty years a whole library of articles for and against Schopenhauer have appeared from time to time, and a complete edition of his works was required by the nation. This tardy recognition threw a golden light over the last years of Schopenhauer's life.—*Illustrirte Zeitung.*

THE ONE HUNDREDTH BIRTHDAY OF SCHOPENHAUER, FEBRUARY 22, 1888.

WILLIAM CROOKES, F.R.S., PRESIDENT OF THE CHEMICAL SOCIETY.

WE doubt if the Chemical Society could have chosen for their president any one in this country with such a brilliant all-round scientific record as that of the gentleman who has held that distinguished position during the past year. Mr. Crookes has been a prominent and successful investigator in so many of the highways and by-paths of chemical and physical research, that it is difficult to assign any special character to his life work. At the present time, he is the pioneer in the region of scientific speculation; at other periods in his career the manufacture of beet root sugar, dyeing and calico printing, and the sewage question, have seemed to absorb his attention. Between these studies of what would be distinguished as practical subjects, he has interjected his wonderfully delicate experiments on "radiant matter," experiments which, while they seemed

at first sight to lead to nothing beyond the construction of the pretty but not very useful radiometer, actually made the electric light a possibility and a success by his demonstrations of the possibility of producing and managing the electric spark in extreme vacua. Among the scientists who have in recent years advanced so rapidly the utilization of the electric light Mr. Crookes has been eminent. In meteorology, in photography, and especially in the development of spectrum analysis, Mr. Crookes has also made his mark. Moreover, he is the only living English discoverer of an element.

Mr. Crookes was born in London in 1832. In 1848 he entered the Royal College of Chemistry as a pupil of the distinguished chemist, Dr. Hofmann, now of the University of Berlin, and at the age of seventeen he gained the Ashburton scholarship. After two years' study he became, first junior, then senior, assistant to Dr. Hofmann until 1854, when he was appointed to superintend the meteorological department of the Radcliffe Observatory, Oxford. In 1855 he became teacher of chemistry at the Science College, Chester. Returning to London, Mr. Crookes added literary labors to his other occupations by the establishment of the *Chemical News*, which he owns and edits to this day. This journal has been the English organ of scientific chemistry during a quarter of a century richer in research than any previous period of the world's history, and a reference to the long row of volumes to which the *Chemical News* now extends will show that the editor has managed, in the moderate space at his disposal, to keep the record of both home and foreign investigation well posted up. The fact that Mr. Crookes has been left so many years in almost undisturbed possession of the particular corner of the field of journalism which he marked out for himself nearly thirty years since is evidence of the satisfactory character of his stewardship.

Besides the *Chemical News* Mr. Crookes has edited the *Quarterly Journal of Science*, and has published the following works: "Select Methods in Chemical Analysis," "Manufacture of Beet Root Sugar in England," "Handbook of Dyeing and Calico Printing," and "Dyeing and Tissue Printing"—one of the "Technological Handbooks" prepared for the examinations of the City and Guilds of London Institute. He is also joint author of the English adaptation of Kerl's "Treatise on Metallurgy." He has edited the last three editions of Mitchell's "Manual of Practical Assaying," and has translated into English and edited Reimann's "Aniline and its Derivatives," Wagner's "Chemical Technology," Auerbach's "Anthracene and its Derivatives," and Ville's "Artificial Manures." Mr. Crookes is an authority on sanitary questions, especially the disposal of town sewage, and his views have been laid before the public in two pamphlets—"A Solution of the Sewage Question" and "The Profitable Disposal of Sewage." In conjunction with Drs. Odling and Tidy, Mr. Crookes is now investigating the sanitary condition of the water supply of London. This list indicates only a section of the studies in which Mr. Crookes has been engaged.

In 1861 Mr. Crookes announced the discovery which at once made him famous among scientific men, and with which his name will ever be associated. He was working on a seleniferous deposit from the sulphuric acid manufactory at Tilkerode, in the Harz Mountains. After distilling some impure selenium prepared from this deposit, a considerable residue was left behind in the retort. This, at the time, he supposed would contain tellurium, and for the moment he put it aside. Subsequently, wanting some tellurium for experimental purposes, he endeavored to obtain it from this residue, but after trying various methods for isolating that metal, he at last resolved to test the substance spectrally. Neither selenium nor tellurium present any strongly marked bands which would be a certain guide in such an examination, so that not much was expected from this analysis. On introducing a portion of the residue into a gas flame, abundant evidence of the presence of selenium was obtained; but as the alternate light and dark bands due to that element became fainter, and while expecting the appearance of the somewhat similar but closer bands of tellurium, a bright green line suddenly flashed into view and quickly disappeared. The experimenter had had some years' acquaintance with most of the artificial spectra and had never met with an isolated green line in that portion of the spectrum before. His attention was arrested, and after thought and further experiment he became convinced that he had found a hitherto unknown element. He at first regarded it as a metalloid, but further examination proved it to be a true metal. He first separated some in a distinct metallic form in September, 1861, six months after the original discovery, and in May of the following year exhibited it in the International Exhibition in London. He named it from the Greek word *thallos*, meaning a green bud. In special recognition of this brilliant research, Mr. Crookes was elected a Fellow of the Royal Society in 1863.

During the next ten years he devoted much time and patient labor to researches into the atomic weight, the occurrence, distribution, and reactions of his new element. He detected it in many kinds of copper and iron pyrites, in crude sulphur, in the flue deposits of pyrites burners, but usually in very minute quantities. In its chemical reactions thallium differs from all other metals. In many respects it resembles the alkali metals, but it is, however, most closely allied to the heavy metals, especially to lead, which it resembles in appearance, density, melting point, specific heat, and electric conductivity.

These studies did not prevent the prosecution of other investigations. In 1865 Mr. Crookes discovered a process for separating gold and silver from their ores by means of sodium amalgamation, which is now very extensively adopted, and is the most economical method in use. In 1866 he was appointed by the government to report upon the application of disinfectants in arresting the spread of the cattle plague, which in that year excited much alarm in England.

In 1871 he was a member of the English expedition to Oran to report upon the total phase of the solar eclipse which occurred in December of that year.

In 1873 he commenced his experiments on "Repulsion Resulting from Radiation." Numerous papers, embodying the record of researches on this subject, were read before the Royal Society between this date and 1880. In these Mr. Crookes showed the effect of light and heat on the molecules of gases in atmospheres of various rarefactions, and he illustrated his observations by the "radiometer" and the "otheoscope," instruments of great beauty and delicacy. He showed that it was possible to measure the force of motion among the molecules of gases, and incidentally he showed how to produce vacua of far greater rarefaction than had ever before been obtained. He reduced air to fifty millionth of an atmosphere, and in a cubic centimeter of such an atmosphere he computed there were contained no less than twenty billions of molecules. Later still he showed that gases when very highly rarefied lose most of the ordinary properties of matter, and pass into a fourth or ultra-gaseous condition.

In 1875 he was awarded by the Royal Society a gold medal for his researches in chemical and physical science, and in 1877 and 1878 was selected Bakerian lecturer of the same society. In 1880 the French Academy of Sciences bestowed upon him a gold medal and an extraordinary prize of 3,000f. in recognition of his discoveries in molecular physics and radiant matter.

At one time in his career—about the year 1871—Mr. Crookes entered upon an investigation which created great interest, but in which he failed to satisfy the scientific world of the accuracy of his observations. Mr. Home, the famous spiritualist, submitted himself, and the manifestations of which he was at times the subject, entirely to Mr. Crookes' analysis. In an article published by the latter he declared his belief that certain phenomena observed could not be due to tricks, legerdemain, or mechanical arrangements, and he proposed the term "psychic force," not as an explanation of, but as a convenient definition for, such manifestations. Some smart conflicts followed this remarkable declaration, in which, from a literary point of view, Mr. Crookes certainly did not get worsted. We believe that we are correct in adding that Mr. Crookes has never abandoned his faith either in Mr. Home or in psychic force, and he is always ready to chivalrously defend the good faith of the late noted "medium."

WILLIAM CROOKES, F.R.S.

Some time since we had occasion to call, upon Mr. Crookes at his handsome residence in Kensington Park Gardens. Chemistry and its associate sciences have evidently dealt liberally with their suitor in this case, as we found him surrounded with luxury enough to enervate any but the most determined student. His house is well known in the electrical world, as it was one of the first where the electric light was given a fair chance regardless of expense, and to a great extent the wires were laid by his own hands. The soft beauty of the fairy light can be turned on to any room through the house, and associated as it is with the most artistic decorations and furniture, his rooms on reception nights present an appearance of refined elegance which suggests, we hope, a future of general domestic beauty as far in advance of our present standard as ours is ahead of that of the tallow candle era. Mr. Crookes himself we found in a spacious room on the first floor, intended probably by the architect for a billiard room, but now dedicated to literature, science, and art.

In this library and the rooms adjoining Mr. Crookes spends the greater part of his life. It is not astonishing if the owner is proud of his library, for it is truly a magnificent one. The apartment is luxurious and comfortable. It was entirely remodeled when Mr. Crookes took possession of it, so that he was enabled to furnish it as best suited his work. All the fittings are of oak, the mantel piece being of the same design as the shelving, and the "nooks" of this piece of furniture are utilized as memoranda cabinets for current events. We should hesitate to estimate the number of volumes in this library, but there are few known works on physical and chemical science which are not to be found in it, and all are lettered and numbered according to the subject matter, each division being lettered, and each book numbered, so that with the aid of a card catalogue any volume may be found in a few seconds.

The apartment is amply lighted by three large windows, close to one of which stands a marvelous secretaire containing a few scores of piegon holes filled with carefully arranged papers. A revolving book stand, containing the most frequently required reference books, stand beside this. There is not much attempt at decoration in the room, for scientific literature requires little else than the art of the bookbinder to make it attractive, and any contrast that is required in this case is afforded by various pieces of physical apparatus, which are kept here for safety. For example, a large and delicate balance stands close to one window, secured from damp and chemical funes. We pass from this into an anteroom, where Mr. Crookes keeps a few of his chemical curiosities, such as electric lamps no bigger than a pea (actually 3·8 millimeters in diameter, and capable of giving a light of one candle power), his original specimen of thallium, together with its more important salts, thorium salts, yttria salts, rare minerals—such as crookesite—and the hundred and one other specimens upon which the owner has at one time or other spent time and money. We have already spoken of Mr. Crookes' work with the electric light. One of the specimens in this glass case reminds us of the way in which he constructed the carbon filament for the glow lamps. Some may know it, but it is worth telling. The great disadvantage of many carbon filaments is that they possess the structure of the substance from which they are made. Mr. Crookes avoids this by dissolving cellulose in a strong solution of ammonio-cupric sulphate; this solution is dried on plates, whereby tough sheets are formed. The copper salt is then dissolved out, and there remains a horn-like material, which on being cut into strips and carbonized forms excellent and structureless filaments.

Again passing through the library, we come to a suit of three apartments, in which Mr. Crookes' researches are conducted; one room is devoted to ordinary chemical work, another is styled the mechanical shop, and the third is for purely physico-chemical experiments. All the work done in these is in the nature of pleasure—that is to say, ultimate remuneration has nothing to do with it—and it is a continuation of that research on the selenocyanides which inaugurated Mr. Crookes' career as an investigator. In his work here Mr. Crookes is assisted by a paid assistant, who is an expert chemist, and occasionally by Miss Crookes, who has fathomed the mysteries of fractionation and the cabalistic signs of the absorption spectrum.

On these laboratories Mr. Crookes spends a considerable sum annually, and his return consists in the pleasure of the work and the honor which science accords to him for it. The chemical laboratory is a well lighted room, 12 feet by 12 feet, and contains all the conveniences for ordinary chemical research. Combustions and other operations which require a high degree of heat are conducted on a bench situated on the south wall; in the center is a large bench, at which the various fractionation operations, such as solution, filtration, and evaporation, are performed. The east wall of the room is occupied with a fume chamber and sink, the latter of which is provided with numerous dripping racks. The reagent shelves are on the opposite walls. All the bottles are made of what is called the "David Forbes" glass, which is less readily attacked by solutions than any other kind of glass. Mr. Crookes, however, has to get his bottles specially made; they are shoulderless, and the stoppers have mushroom tops, which is a very convenient form, as it keeps the neck of the bottle free from dust and provides good leverage for the removal of the stopper. Most of the work done in this room is in the nature of fractionations, and each stage of an experiment, with its results, and the time at which the work was done, are recorded in a substantial and large sized laboratory book. We found from the note in this book made on the morning that we visited the laboratory, that the 714th fractionation of yttria was being worked at, and we traced this set of experiments as far back as 1881, and yet had not exhausted the record; the fact is that all the work which Mr. Crookes has done has had a common origin. The selenocyanides created intimacy with selenium; a seleniferous deposit yielded him the element thallium; the spectroscopic study of that led to various optical researches, which required vacuum apparatus.

A practical knowledge of the latter naturally induced Mr. Crookes to study the possibilities of the glow lamp when electric lighting became a craze; and so the work has gone on. One can scarcely see the connection between many of the papers. What, for instance, has the photography of the moon to do with the genesis of the elements? Apparently nothing; but a search of Mr. Crookes' note books shows that both subjects are natural outcomes of his lifelong research.

From the chemical laboratory we pass into the mechanical room. This is fitted with benches for glass and metal work, all the apparatus, such as vacuum tubes for the spectroscope examination of radiant matter, and the L shaped wedge tubes for examining fractionation solutions, being made on the premises. It is the physical laboratory, on the west side of the mechanical room and opening into the library, which is the most interesting room. Here are kept in the spare space specimens of all important substances and solutions which have been the bases of theories promulgated by Mr. Crookes during the past quarter of a century. Each specimen is packed in a box. The principal use of this laboratory is for spectroscopic work, and this may be said to be of three kinds—(1) preliminary observations of absorption spectra; (2) observations of the electric spark in vacuo; and (3) corroborative observations with a very fine instrument. As soon as a fractionation of a substance, say yttria, is finished, an L tubeful of the solution is at once taken into the physical laboratory and examined with the small spectroscope, the lines are observed and mapped down by the observer, and a note of the observation made.

In the course of the hundreds of such observations with the rare earth yttria, Mr. Crookes has been enabled to show that by fractionation the individual bands of the half dozen or more which constitute the absorption spectrum of that body are separable, and he has so separated yttria into individual yttrias which are chemically identical, but molecularly different. The work with the spark spectrum is carried on very smoothly, for there are several installations of electricity in the room which can be utilized at any moment and at very little cost. Thus the spectrum of samarium, the residual glow of the ruby, or any other physical experiment of this nature, generally requiring extensive preparation and much anxiety, can be shown as easily and quickly as the existence of a soluble sulphate can be proved in any solution. It is seldom that Mr. Crookes has to use his finest spectroscope, for by long experience he and his *alter ego* know so well what the smaller one indicates that the large instrument has only to be appealed to when a paper for some scientific society has to be written. In this physical laboratory are also placed the marvelous Sprengel pumps, with which Mr. Crookes has produced the greatest degree of rarefaction known.

Work in these laboratories is daily carried on as if it

were a laboratory attached to a commercial house. The assistant comes at a fixed hour every day, and puts in an honest day's work. If he breaks off at any time, his notes in the laboratory books show how far the experiment has advanced, and here it can be taken up by Mr. Crookes and finished with perfect knowledge of what has preceded. So also in the opposite sense. It is obvious that this complete system of note taking must materially simplify what is generally a laborious process, viz., transmitting facts and figures into an intelligible paper or reasonable hypothesis. So simple, indeed, does the process become that Mr. Crookes, gifted with a retentive memory, sits down when the notes become voluminous, and prepares a monograph or one of a series of papers for the Royal Society.

It is not possible to do adequate justice to the work and workers in these private laboratories; but perhaps details are of secondary importance in comparison with the virtues which have actuated this modern philosopher in his labors, viz., continuity, method, and perseverance.—*Chemist and Druggist.*

[Continued from SUPPLEMENT, No. 641, page 10236.]

ON A TRIAL OF A WATER TUBE BOILER AT SIBLEY COLLEGE, CORNELL UNIVERSITY.

By R. H. THURSTON.

AT the time of taking the samples of gas the conditions were as follows:

No. 1. Fire had not completely burned clear from first firing. Back damper was wide open, as were the draught doors.

No. 2. Fire burning clear. Back damper dropped 3 inches. Draught doors wide open.

No. 3. Fire clear. Back damper 3 inches down. One draught door closed.

No. 4. Fires clear. Back damper 6 inches down. One draught door closed.

No. 5. Same as No. 4.

From these figures the following results are obtained:

FLUE GASES.

Average free O,	by weight,	7·108	per cent.
" CO_2,	" "	17·059	"
" CO,	" "	2·584	"
" N,	" "	73·34	"

The average ratio of the amount of air for *dilution* of the gaseous products of combustion to that necessary for combustion is as 0·514 to 1, *i. e.*, 16·44 lb. of air per pound of combustible, or 1·37 times the theoretical amount. The ratio of amount of air required for the dilution of the gaseous products of combustion to that necessary for combustion is variously estimated by different authors, but is generally taken as ½ : 1. It will be seen that a very small per cent. of CO passed up the chimney, the average being 2·67 per cent. by volume, showing the combustion to be nearly complete.

The waste by air in the chimney is calculated by the following formula:

Let N = the number of pounds of air for combustion and dilution.
t = temperature of chimney.
t' = temperature of external air.
S = specific heat of same.

Then—

$$V = N(t - t')\,S.$$

Where V is the number of heat units carried off by the escaping gases.

We have

$$N = 16{\cdot}44.$$
$$t = 435{\cdot}7^\circ \text{ Fahr.}$$
$$t' = 60{\cdot}39^\circ \text{ "}$$
$$S = 0{\cdot}238$$

Hence—

$$V = 16{\cdot}44\,(435{\cdot}7 - 60{\cdot}39)\,0{\cdot}238 = 1468{\cdot}48 \text{ units.}$$

Assuming that a pound of coal will evaporate 15 pounds of water from and at 212° Fahr., or equal to 14,491 heat units, the loss by chimney is 0·101.

The height of chimney required under the above conditions is found from Rankine's formulæ as follows:

Let W = weight of fuel burned in the furnace, per second.
V_0 = the volume at 32° F. of air supplied per lb. of fuel.
T = the absolute temperature of gas discharged by the chimney.
A = Sectional area of damper opening.

Then the velocity of the current in the chimney in feet per second is $u = \dfrac{W\,V_0\,T}{A\,T_0}$

Hence

$$u = \frac{0{\cdot}06869\,(12{\cdot}386 \times 16{\cdot}45)\,896{\cdot}9}{2{\cdot}222 \times 493} = 11{\cdot}449 \text{ ft. per sec.}$$

and h the head required to produce this draught, is,

$$h = \frac{u^2}{2g}\left(1 + G + \frac{f\,l}{m}\right)$$

where

L = the whole length of chimney and flue leading to it in feet.
M = its hydraulic mean radius.
F = coefficient of friction. (Estimated by Pectet at 0·012)
G = a factor of resistance for the passage of air through grate and fuel. (Given by Pectet as 12.)

Hence—

$$h = \frac{(11{\cdot}449)^2}{2 \times 32{\cdot}2}\left(13 + \frac{0{\cdot}012 \times 93}{534}\right) = 30{\cdot}7138 \text{ ft.}$$

Then,

$$H = h + \left(0{\cdot}96\,\frac{T_1}{T_2} - 1\right)$$

where H is the height of chimney,

$$H = 30{\cdot}7138 + \left(0{\cdot}96\,\frac{896{\cdot}9}{521{\cdot}59} - 1\right) = 47{\cdot}25 \text{ ft.}$$

The actual height as measured was 60·25 ft. The difference between this and the calculated height, or the throttling effect of the damper, being

$$60{\cdot}25 - 47{\cdot}25 = 13 \text{ ft.}$$

The following data were taken during the trial:

COAL RECORD.

Time.	Weight of Wood.	Weight of Coal.	Weight of Ash.
7:50 A.M.	245·5 lb.	98·2 lb.	....
7:55 "	....	204 "	....
8:00 "	....	200 "	....
8:05 "	....	200 "	....
8:10 "	....	200 "	....
8:48 "	....	200 "	....
8:57 "	....	200 "	....
9:40 "	....	200 "	....
10:08 "	....	200 "	....
10:45 "	....	200 "	....
11:25 "	....	200 "	....
11:45 "	....	200 "	....
12:27 P.M.	....	200 "	....
1:25 "	....	200 "	....
1:50 "	....	200 "	....
2:00 "	....	....	200 lb.
3:23 "	....	200 "	....
3:50 "	....	200 "	....
4:50 "	....	61 "	....
6:00 "	....	weighed back 400 lb.	142 lb.

Total coal.......................... 2963·2 lb.
Total ash and waste.................... 342 "
Per cent. ash and waste................ 11·5

The wood used was considered as equal to 0·4 the same weight of coal.

At 6 P. M. the fire was hauled and the unconsumed coal and the contents of the ash pit were weighed up dry. The height of water in the gauge glass was brought to the same position as at the start, and all conditions made as near those at the beginning of the trial as possible.

The following are the records:

FEED WATER.

Time.	Total Weight.	Weight of Barrel.	Net Weight.	Temperature
	lb.	lb.	lb.	Fahr.
7:45 A.M.	497	83	414	58
:57 "	483	77	406	58
8:20 "	485	83	402	48
:35 "	504	80	424	46
:46 "	500·5	79	421·5	45
:55 "	509	79·5	429·5	44
9:05 "	509	80	429	45
:11 "	502	79	423	45
:20 "	505·5	76·5	429	46
:34 "	506	77·5	428·5	46
:47 "	506·5	81	425·5	45
:52 "	506	81·5	424·5	46
:58 "	506·5	77·5	428	46
10:17 "	506	80	426	46
:27 "	509	76	433	46
:33 "	505	81	424	46
:40 "	506·5	76·5	430	46
:55 "	507·5	78	429·5	46
11:05 "	507	80	427	46
:10 "	504	75	429	46
:30 "	504·5	82·5	422	46
:40 "	506·5	78	428·5	46
:48 "	507·5	79	428·5	46
:56 "	506	79·5	426·5	46
12:08 P.M.	504	79·5	424·5	46
:20 "	508	79·5	428·5	46
:30 "	510·5	77	433·5	46
:43 "	505·5	78·5	427	46·5
:55 "	515	80·5	434·5	46
1:00 "	505	79·5	425·5	46
:13 "	505·5	77	428·5	46
:25 "	404·5	81	423·5	46
:38 "	505	80	425	46
:45 "	504·5	77	427·5	46
:55 "	504·5	78·5	426	46
2:05 "	505	80·5	424·5	46
:28 "	505·5	75	430·5	47
:38 "	503	80	423	46·5
:43 "	506·5	79·5	427	46
:52 "	506·5	78	428·5	46·5
3:05 "	506	77·5	428·5	46
:13 "	504	79	425 ·	46·5
:22 "	505	80·5	434·5	47
:38 "	506·5	78·5	428	48
:48 "	506·5	77·5	429	48
4:00 "	502	77	425	47·5
:07 "	506·5	78·5	428	47
:18 "	506·5	79	427·5	47
:26 "	506·5	81	425·5	47
:37 "	503	82	421 *b*	47
:53 "	503	76·5	426·5	47
5:00 "	500	77	423	47
:07 "	506·5	80	426·5	47
:13 "	507	79	428	47
:24 "	505	79	426	47
:38 "	508	77·5	430·5	47
:50 "	505	44·1	64	47

Total weight of water........ 23,912·5 lb.
Average temperature.......... 46·125 Fahr.

TEMPERATURES.

Time.	Pyrometer.	Corrected.	Boiler Room.	Outside Air.	Draught Pressure in Water.
	Dg. Fahr.	Dg. Fahr.	Dg. Fahr.	Dg. Fahr.	Inches.
8:00 A.M.	330	373	72	62.75	275
8:30 "	380	432	75	63	275
9:00 "	360	409	78·25	67	275
9:30 "	360	409	80	67	275
9:50 "	370	420	78	63	275
10:20 "	380	432	80	63·5	275
10:50 "	385	438	82	64	275
11:20 "	390	445	83	64	275
11:50 "	390	445	81	64	275
12:20 "	390	445	80	64·5	275
12:50 "	390	445	82	63	275
1:20 P.M.	385	438	83	62	275
1:50 "	390	445	81	61	300
2:20 "	390	445	83	56·5	275
2:50 "	395	450	82	55	275
3:20 "	392	447	82	56	275
3:50 "	390	445	82	55	275
4:20 "	400	456	81	55	275
4:50 "	400	456	82	54·5	275
5:20 "	395	450	79	53·5	275
5:50 "	375	425	76	54	275

PRESSURES.

Time.	Mercury Gauges.	Barometer Reading.
8:05 A.M.	84 lb.	28·971 in.
8:15 "	90 "	
8:30 "	88 "	
9:00 "	87 "	
9:17 "	86 "	
9:30 "	82·5 "	
9:50 "	87·5 "	
10:13 "	86 "	
10:20 "	84 "	
10:50 "	81 "	
11:10 "	86 "	
11:20 "	85 "	
11:50 "	87 "	
12:15 P.M.	86 "	
12:20 "	85 "	
12:50 "	87·5 "	
1:15 "	87 "	
1:20 "	88 "	
1:50 "	86 "	28·668 in.
2:20 "	86 "	
2:20 "	87·5 "	
2:50 "	86 "	
3:10 "	86 "	
3:20 "	87 "	
3:50 "	86 "	
4:10 "	86 "	
4:20 "	86 "	
4:50 "	84·5 "	
5:10 "	85·5 "	
5:20 "	87 "	
5:50 "	85 "	28·468 in.

AVERAGE PRESSURES.

Mercury gauge........................ 85·78 lb.
Edson gauge, by record chart, corrected........................ 85·4 lb.

The barometer readings were taken from the report of the university signal service.

CALORIMETRIC EXPERIMENTS.

No.	Time.	Wt. of Bbl.	Wt. of Bbl. and Cond'n'g Water.	Final Weight.	Initial Temp. C.	Initial Temp. Fahr.	Final Temp. C.	Final Temp. Fahr.
1	8:15	63·1	424·6	449·25	6·66	44	47·55	117·6
2	9:15	63·1	442·50	468·00	9	48·2	50	122
3	10:15	63·1	442·25	467·10	9·2	48·56	48·7	119·66
4	11:15	63·1	443·15	469·00	9	48·2	50·1	122·18
5	12:15	63·1	448·70	474·75	9	48·2	49·5	121·1
6	1:15	63·1	451·20	475·85	9·1	48·38	47·3	117·14
7	2:15	63·1	451·85	475·00	8·9	48·02	44·8	112·64
8	3:15	63·1	452.60	475·70	9·6	49·28	46	114·8
9	4:15	63·1	451·35	478·40	9	48·2	43·7	111·66
10	5:15	63·1	452·20	476·15	9·3	48.75	46·4	115·52

Let x = weight of dry steam run into calorimeter.
y' = weight of water in the steam.
y = percentage of priming.
W = weight of condensing water.
w = weight of condensed steam.
t'' = the intial temperature.
t' = the final temperature.
T = heat units per lb. of steam.
t = heat units per lb. of water.

Then

Range of temperature.................. $R = t' - t''$
Heat transferred to calorimeter....... $U = WxR$
Heat from steam per lb................ $H = T - t'$
Heat from water per lb................ $h = t - t'$

$x + y' = w$ 1
$Hx + hy' = U$ 2

From 1 and 2:

$$x\,(H - h) = U - wh.$$

$$x = \frac{U - wh}{H - h}$$

Percentage of priming:

$$y = 100\,\frac{w - x}{w}$$

The ten calorimeter experiments gave the following average results:

Steam pressure.............................. 100·522 lb.
Weight of condensing water.............. 382·985 "
Weight of steam condensed................. 24·335 "
Initial temperature.......................... 47·979 Fahr.
Final temperature......................... 117·430 "
Range of temperature......................... 69·45 "
Dry steam run into the calorimeter....... 24·2853 lb.
Per cent. of priming.......................... 0·189

DATA AND RESULTS.

Date of test.................................April 28, 1887.
Weight of wood used in lighting fires.......... 245·5 lb.
Equivalent value of wood referred to fuel.... 98·2 "
Weight of anthracite coal used.............. 3265 "
Total weight of fuel...........................3363·2 "
Weight of unconsumed coal left on the grates, 400 "
Total weight of fuel consumed...............2963·2 "
Weight of ashes and clinkers................ 342 "
Percentage of ash and clinkers to fuel consumed.................................. 11·5
Percentage of moisture in coal................ 3·81
Weight of fuel less moisture...................2752·11 lb.
Weight of combustible used.....................2410·11 "
Total weight of feed water supplied and evaporated.......................................23912·5 "
Average steam pressure........................ 85·4 "
Average temperature feed water.............. 46·71 Fr.
Average temperature of escaping gases....... 435·7 "
Average force of draught in inches of water.. 0·275 in.
Water evaporated per lb. of fuel, observed conditions.................................. 8·68 lb.
Equivalent evaporation, per lb. of fuel, from and at 212° Fahr.............................. 10·436"
Water evaporated per lb. of combustible..... 9·92 "
Equivalent from and at 212.................... 11·984"
Average temperature of boiler room.......... 80·06 Fr.
Average temperature of outside air.......... 60·39 "
Average height of barometer.................. 28·702 in.

PRIMING TESTS.

No.	Time.	Steam Press. Absolute	W.	w.	t''	t'	R=t'—t''	Water t.	Steam T.	U=WR	H=T—t'	λ=t—t'	y
1	8:15 A.M.	104·12	361·50	24·65	44	117·6	73·6	330·55	1212·213	1094·613	212 915	24·223	1·73
2	9:15 "	100·12	379 40	25·50	48·2	122	73·80	327·711	1211·422	1089·422	205·711	25.748	0·97
3	10:15 "	100·12	379·15	24 85	48·56	119·66	71·10	327·711	1211·422	1091·762	208·051	24·654	0·79
4	11:15 "	100·12	380·50	25·40	48·20	122·18	73·98	327·711	1211·422	1089·242	205·531	25·946	2·14
5	12:15 P.M.	100·12	385·60	26·05	48·20	121·10	72·90	327·711	1211·422	1090·322	206·611	25·718	1·27
6	1:15 "	101 12	388·10	24·65	48·38	117·14	68·76	328·430	1211·621	1094·481	211·290	24·318	1·34
7	2:15 "	100·00	388·75	23·15	48·02	112·64	64 62	327·625	1211·398	1098·758	214·985	22 793	1·54
8	3:15 "	100·00	389·50	23·10	49·28	114·80	65·52	327·625	1211·398	1096·598	212·825	23·313	0·92
9	4:15 "	100·00	388·25	22·05	48·20	111·66	63·46	327·625	1211·398	1099 738	215·965	22 490	1·99
10	5:15 "	95·50	389 10	23·95	48·75	115·52	66·77	327·262	1211·296	1095·776	211·742	23·651	1·24

Horse power developed on a basis of 30 lb. of feed water supplied at 100° Fahr. and evaporated at 70 lb.	83·75
Rated horse power	61
Per cent. above rated capacity	37

THE EAMES VACUUM BRAKE.

The Eames vacuum brake is now in use on 240 different railways in the United States and South America, and at the late railway brake trials at Burlington, United States, it beat all competitors on certain points. These trials came off in May last, each company fitting up fifty vehicles. The following advantages are claimed for the Eames system: (*a*) Simplicity of construction; there are no intricate or delicate parts, and no complex valves, packed pistons, or stuffing boxes. (*b*) Facility of manipulation; it is easily understood and manipulated, and requires no skill to keep it in order. (*c*) No air pump is employed, and the compressed air system is avoided.

The practical utility of the brake is best shown by the fact that it is exclusively used on every locomotive and carriage on the New York Elevated Railway and the Brooklyn Bridge Railway, making 100,000 stops daily on the former line, where it has been in use for five years on an equipment of over 1,000 passenger carriages and 400 locomotives without a single failure. There is no oil used, and the saving in oil alone, as compared with other systems, will, it is stated, in course of time pay for the brake. The release is instantaneous, and no time nor power is expended in effecting it. The driver has complete control of the train and can regulate the brake power to as much or little as he may desire, and also handle the train with this brake in perfect safety on any gradient on which a locomotive can be run. The cost of the brake is, we are told, much less than either the Westinghouse or Smith's vacuum, and the Eames Vacuum Brake Company will guarantee the diaphragm for three years. The brake is now working successfully on gradients of 1 in 25, and has been operated for four years without a single failure.

So much premised, we may proceed to describe the brake. Our engravings show two varieties—one, the brake as fitted to coaches, the other an engine, or, as the company call it, a "driver" brake, because it acts on the driving wheels of the engine.

The first, or "plain brake," consists of an ejector, a continuous line of pipe connecting the diaphragm with the ejector, the couplings on the ends of the flexible hose, and the diaphragm pots, by which the brake blocks are applied. The ejector is shown by Figs. 1 and 2.

The operation of this ejector is as follows: The movement of the lever, 41, opens the steam valve, B49. This is a slide valve, and is moved over the port in valve seat, C49, by the valve stem, B51. The steam, entering at A50, passes through this valve, and enters the steam chamber, A1. The steam rushes upward around the end of the tube, 5, its velocity being accelerated in passing through the contracted opening at the top of the tube. Passing through tubes 3 and 8, the steam shoots up in the form of a column with a hollow base; the tube, 5, which is connected through 54, C4, and the check valve, B7, with the pipes and diaphragms on the train, forming this base. The effect of the steam passing out under these conditions is to induce a current through the tube, 5, which draws up the valve, B7, and sucks the air out of the pipes and diaphragm pots. Upon shutting off the steam, the valve, B7, closes the air pipe, and the vacuum in the pipe and diaphragms is maintained until the air is allowed to enter through the release valve, 8, by the movement of lever, 25. 59 is a ball drip for the escape of water when deposited in steam chamber, A1, by condensation. A16, which terminates in the drip pocket, 56 57 58, serves the same purpose for the lower body of the ejector, D2. 53 is a jacket surrounding the pipe, 8; it passes up through the roof of the cab, having a thread at the upper end to connect it with a muffler for deadening the noise of the escaping steam.

The movement of the lever, 41, over the quadrant, A30, is limited by the quadrant studs, 42 and 43. When the lever is against the left hand stud, the valve, B49, is wide open; when against the right stud the valve is closed. The lever will remain in any position between the two studs, opening the port in the valve seat more or less, and graduating the amount of vacuum, and the consequent power applied to the brakes. B59 is a copper tube with a union, 12, on either end, and connects the air pipe just below the check valve, B7, with the vacuum gauge shown in Fig. 1. This ejector is very simple in its construction. It has but two movable parts. The only parts which are liable to wear are the valve and seat, B49 and C49. The seat is raised and can easily be ground when necessary, or replaced at a trifling expense. It is reached by removing the bolts, which are shown upon Fig. 1, immediately to the left of the vacuum gauge, and which connect the castings, B28 and A1. In case of any obstruction to the air check valve, B7, it may be reached by removing the screw cap, O4. These ejectors are all made with interchangeable parts, so that any part which is broken or destroyed can be renewed by sending for the number.

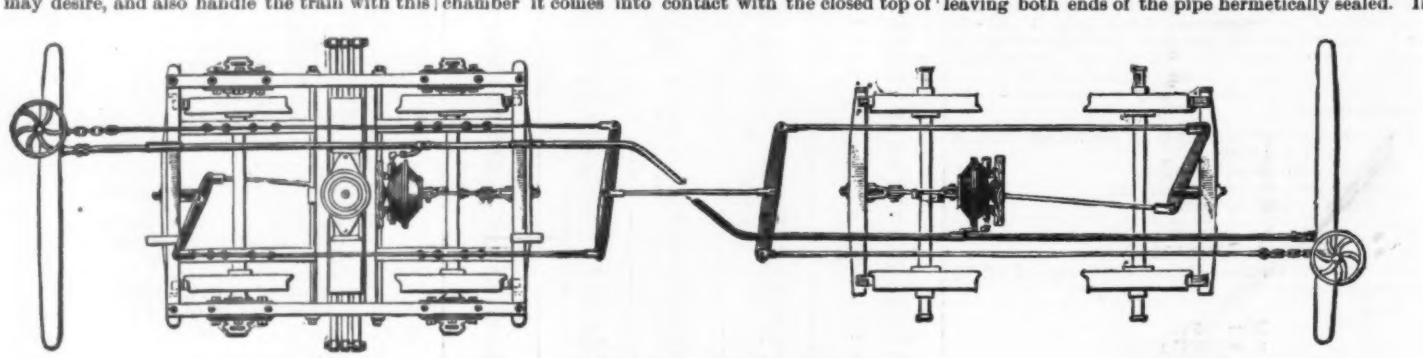
The muffler, which is used to deaden the sound of the escaping steam, consists of a cylindrical casting, containing a series of concentric sheet iron cylinders, fastened alternately to the top and bottom plates. When the plates are placed in their respective positions at the top and bottom of the cylindrical casting, these sheet iron cylinders shut into each other, and form a series of chambers, open alternately at the top and bottom, and increasing in area from the central to the outer chamber. The middle chamber is open at the top; the second chamber is closed at the top and open at the bottom; the third chamber is open at the top and closed at the bottom; and so on through the entire series. The steam passes into the middle chamber direct from the exhaust pipe. Upon leaving this chamber it comes into contact with the closed top of the second chamber—which envelopes the first chamber—and is forced downward through the second chamber. Upon leaving the second chamber at its bottom, it comes into contact with the closed bottom of the third chamber—which envelops the second chamber—and is forced upward through the third chamber. This process is repeated through the series of chambers, until the steam finally escapes into the open air through a number of fine perforations in the top of the outer chamber. The velocity of the steam diminishes as the area of the chamber increases, and its final escape is noiseless. The condensation passes through the bottom plate of the muffler by means of apertures, and is carried away by a drip pipe.

The equipment, Fig. 8, of the train is easily understood. The pipe used under the cars is common gas pipe, 1½ in. in diameter for standard gauge, and 1¼ in. in diameter for narrow gauge cars. This pipe crosses under the center of the car, coming out at each end on the side of the draw bar toward the hand brake wheel, and about 12 in. or 15 in. from the center line of the car. This pipe is attached to the bottom of the car by pipe clips, which are furnished with each equipment. Connection with this iron pipe is made by means of a T; a piece of hose, Fig. 3; hose nipple; hose connection; and double thread nipple. Attached to the ends of the iron pipe, by a goose neck, 16, Fig. 3, is a piece of rubber hose, usually 22 in. in length, ending in the couplings, 15. The goose neck and coupling are attached to the hose by the hose clips 17 and 18, 17 having an eye, by which the hose may be hung up when at the rear end of the train.

The diaphragm pot consists of a kettle shaped iron casting, Fig. 4, with a loose disk of heavy, rubbered duck, 2, fastened over its mouth by means of a ring, 3, and diaphragm cap screw, 6, the center of the rubbered disk, or diaphragm, being provided with washers 4, and an eye bolt, 5, for attachment to the brake lever. The diaphragm pot is attached to the transom of the truck, or car body, by coach screws, the back of the diaphragm shell being provided with lugs for that purpose. The disk is made of such shape as to require the least exhaust of air, and at the same time to have sufficient length of stroke to give the necessary motion to the brake blocks. It consists of two layers of canvas, cut to proper shape, and double stitched with a layer of rubber between and on both surfaces. The rubber serves to make the disk air tight, the requisite strength being given by the canvas. The rubber is compounded expressly for these disks from the best quality of Para gum, and the canvas is also made expressly for them. They are made of different sizes for different weight of cars, and according to the power that it is desirable to apply to the wheels. The sizes which are ordinarily used, and the uses to which they are applied, are as follows: No. 2½, used upon the tender to brake both pair of trucks, and sometimes upon engines for driver brakes. Inside diameter 20¼ in.; area, 322 square inches; length of stroke, 9⅜ in. No. 3, used with standard gauge car equipment. Inside diameter, 18⅜ in.; area, 265 square inches; length of stroke, 9 in. No. 4, used for narrow gauge car equipment, and also for driver brakes. Inside diameter, 15½ in.; area, 188 square inches; stroke, 9 in. The diaphragms when worn out are replaced by removing the cap screws, 6, and the ring, 3, which can be quickly and easily done.

The hose used with the Eames brake is manufactured expressly for the purpose, under patents which are controlled by the company, and is claimed to be greatly superior to any brake hose to be found in the market. It is made in corrugated form, which not only gives it great flexibility, but largely increases its durability. The ordinary plain rubber hose, after short use, especially in cold weather, becomes hard and stiff, and is very liable to wrinkle and crack from the bending to which it is subjected in coupling and uncoupling. This liability is particularly manifest at the point of attachment to the iron air pipe, where the strain is mainly felt after the pipe becomes stiff and rigid, and ceases to bend easily throughout its entire length. The corrugated hose, on the contrary, is said to retain its flexibility, and when bent yields with equal readiness at every point in its length, equalizing the strain and wear, obviating all tendency to crack in the middle or at the mouth of the iron pipe, and is consequently not only very much more durable, but much easier to handle.

The couplings are what are known as butt couplings, and are very simple. They interchange at either end of the cars, and, being arranged so as to separate only when drawn apart in the direction of their length, will uncouple only when the cars are separated, unless uncoupled purposely by hand. In case of accidental separation of the train, the valves instantly close both couplings, leaving the pipe air tight, and the portion of the train which remains attached to the engine fully under the control of the engineer. These couplings are shown in detail in Figs. 5 and 6, in which is a rubber gasket, moulded to fit, and forced into the valve opening. The coupling is joined by raising the valves, 1, and bringing the gaskets together—the couplings being held together by a projection on the valve, 1, which fits into a groove on the point, 3. When the coupling is separated, the spring, 6, closes the valve, leaving both ends of the pipe hermetically sealed. In our engraving 1 is the coupling valve, 2 coupling body, 3 coupling point, 4 coupling pin, 5 gasket, and 6 coupling spring.



THE EAMES VACUUM BRAKE.

As to the cost of the brake, we learn from the company's catalogue that it can be fitted complete to an engine for £29, and to each car for £13.

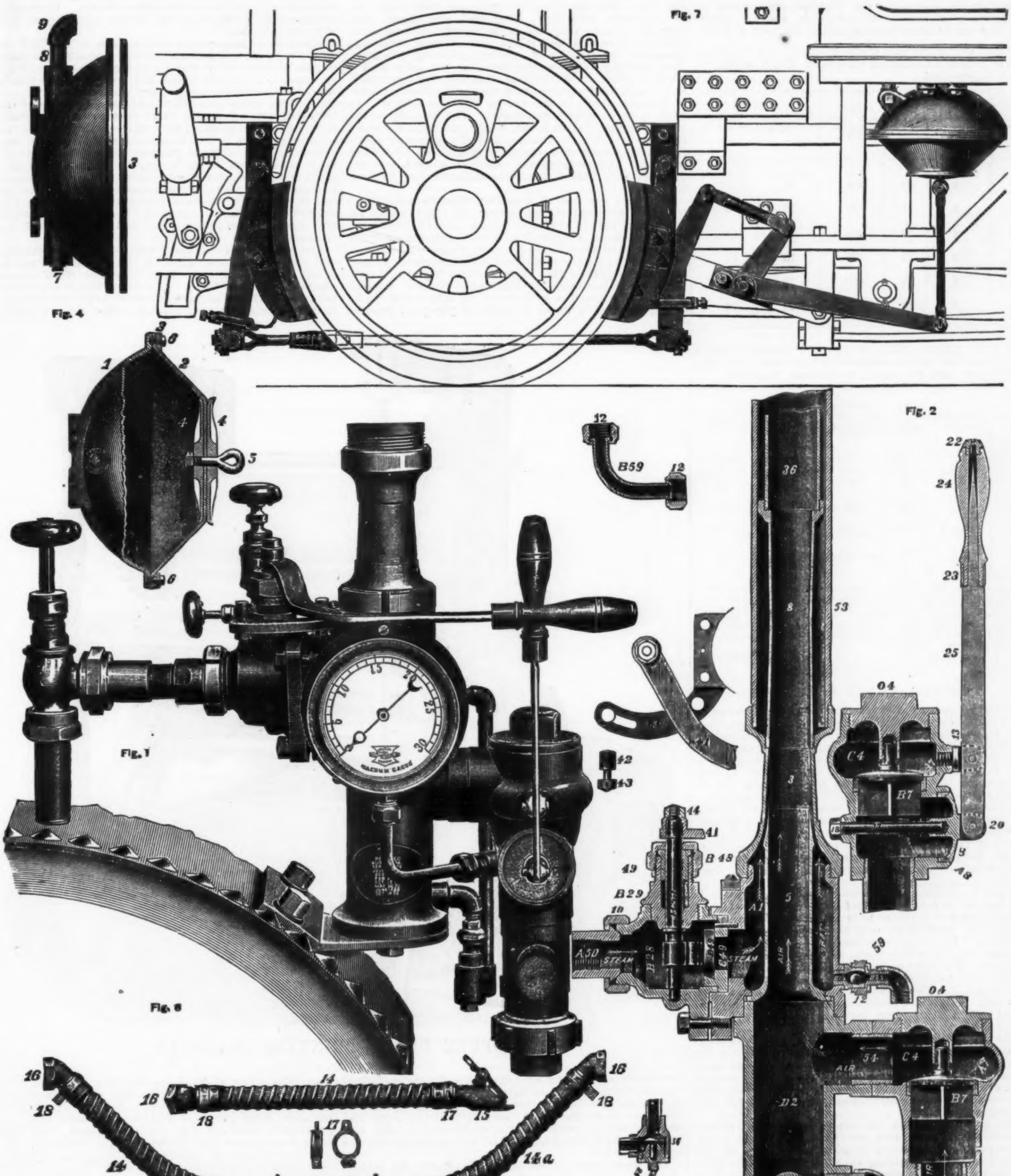
The driver brake is worked by an ejector, and is very similar to that which we illustrate, and the diaphragms and ports are identical with those already described. The exhaust steam is, however, blown into the engine chimney instead of through the roof of the cab, a muffler consisting of a perforated tube being fitted in the petticoat pipe in the smoke box. One method of fitting up the engine is shown by Fig. 7, but several clever arrangements are available to suit different styles of engine and the varying tastes of locomotive superintendents.

This appears to be a very good brake, extremely simple, and very unlikely to get out of order. The great objection to it is that it is not automatic. But, as we have already said, less importance is attached to this abroad than at home, and very great care seems to have been taken to render the brake so simple and strong that there is nothing to give way. The company also makes an automatic brake.

It is an interesting circumstance that this brake is in use on one of the loftiest mountain railways in the world, namely, the Callao, Lima, and Oroya line. This railroad runs from the sea level to an elevation of nearly three miles in a distance of 104 miles, through a temperature varying from torrid heat to that of perpetual snow. The Eames Vacuum Brake Company contracted with this road to equip a train with an apparatus capable of producing a sufficient vacuum at an elevation of 15,645 ft. above the sea, and of handling a train safely on inclines of 1 in 25. The result of the experiment was so satisfactory that the entire road was equipped with this brake, and has been so operated up to this time without a single failure. A more conclusive test of the efficiency of a brake under extreme variations of temperature cannot be imagined. Certain trials were made with the Eames brake on this line, and a report was drawn up by Mr. H. Eardly Wilmot, resident engineer of the line, Mr. J. Backus, superintendent, Mr. Young, manager of the Lima Railway Co., and others, and sent to Mr. Henry Meigs, upon the 17th of September, 1886. This report is worth reproducing, dealing, as it does, with action of the brake on tremendously steep inclines.

"The trial," says the report, "was made from Surco, a little more than fifty-five miles from Callao, at an elevation of 6,655 ft. above the sea level, in many cases

THE EAMES VACUUM BRAKE.



on a grade of fully four per cent. The new brake was tested frequently on the most severe grade of the road, in comparison with the ordinary hand brake, showing the most satisfactory proof in favor of the vacuum brake, as will be seen from the appended statements, which were made from personal observation. In all cases in which there was the slightest discrepancy in noting time, the results are not given, and the following show our unanimous conclusions and test of facts:

TRIALS MADE WITH THE ENGINE OROYA AND TENDER, AND THREE PASSENGER COACHES, FROM SURCO TO SAN BARTOLME.

No. of Trial.	Descending Grade.	Miles per Hour.	Distance Run After Applying Brakes	Time Spent in Stopping.	Vacuum Indicated.
	Per cent.		Feet.	Seconds.	Inches.
1	4	20	650	26	$14\frac{1}{8}$
2	4	21	660	26	$14\frac{1}{2}$
3	4	20	380	17	$15\frac{1}{8}$
4	4	15	270	15	16
5	4	25	810	28	15
6	4	28	690	22	16

TABLE OF TRIALS MADE WITH THE ENGINE OROYA AND TENDER, FIVE PASSENGER COACHES, AND ONE BAGGAGE CAR, FROM SAN BARTOLME TO LIMA.

No. of Trial.	Descending Grade.	Miles per Hour.	Distance Run After Applying Brakes.	Time Spent in Stopping.	Vacuum Indicated.
	Per cent.		Feet.	Seconds.	Inches.
7	3	31	560	22	15
8	3	25	530	21	14
9	3 to 4	30	2,850	96	Hand brake.
10	2·8	35	not taken	26	15

Notes.—No. 1: Trial No. 9 was made with the ordinary hand brakes, in order to show the comparison between them and the vacuum brake, with which all the other trials were made. No. 2: The engine weighs 40 tons, and the tender, loaded, 24 tons. No. 3: Brakes were applied to the wheels of the tender only. No. 4: The apparent discrepancy in the distance run after the brakes were applied is owing to the numerous curves in the road.

—*The Engineer.*

COPPER PLATE PRINTING.

With the exception of the 6 in. map of the counties south of Lancashire and Yorkshire and that of Scotland, all the maps engraved on copper are printed direct from the copper plate, and not from a transfer to stone or zinc. The reason for adopting this course is that very few copies (six to ten) are printed at any one time, so that printing from a transfer would be more expensive than printing direct from the copper.

In the case, however, of the exceptions noted above, the impressions are obtained from a transfer to zinc, for reasons that will appear presently; but the Lancashire and Yorkshire 6 in. maps are printed direct from copper, because some of these plates are too much worn to admit of good transfers being made from them.

When a copper plate is to be printed from, it is first cleaned to remove any old ink, etc., after which it is placed on a steam table to be warmed. The printing ink is then smeared all over the plate by means of a "dauber." Considerable pressure has to be applied by the man who does this work, to force the ink into the lines, etc. The next operation is to remove the greater part of the superfluous ink with a cloth made of scrym, after which the plate is wiped with a cloth wetted with soda ash. Lastly the plate is sprinkled with water and wiped with a clean cloth, leaving the engraved lines full of ink.

The plate is now ready for printing, and to prevent it from getting cold it is placed without delay in the printing press. For many years these presses were worked by hand, but quite recently a steam press has been erected, which will be described further on. The same series of inking operations are required for each impression.

The paper on which the copies are printed should be mentioned; that used for the 6 in. plans is a machine made wove paper, weighing about 130 lb. per ream, for sheets measuring 40 in. by 27 in., and is fairly satisfactory, and similar paper is used for the 1 in. map.

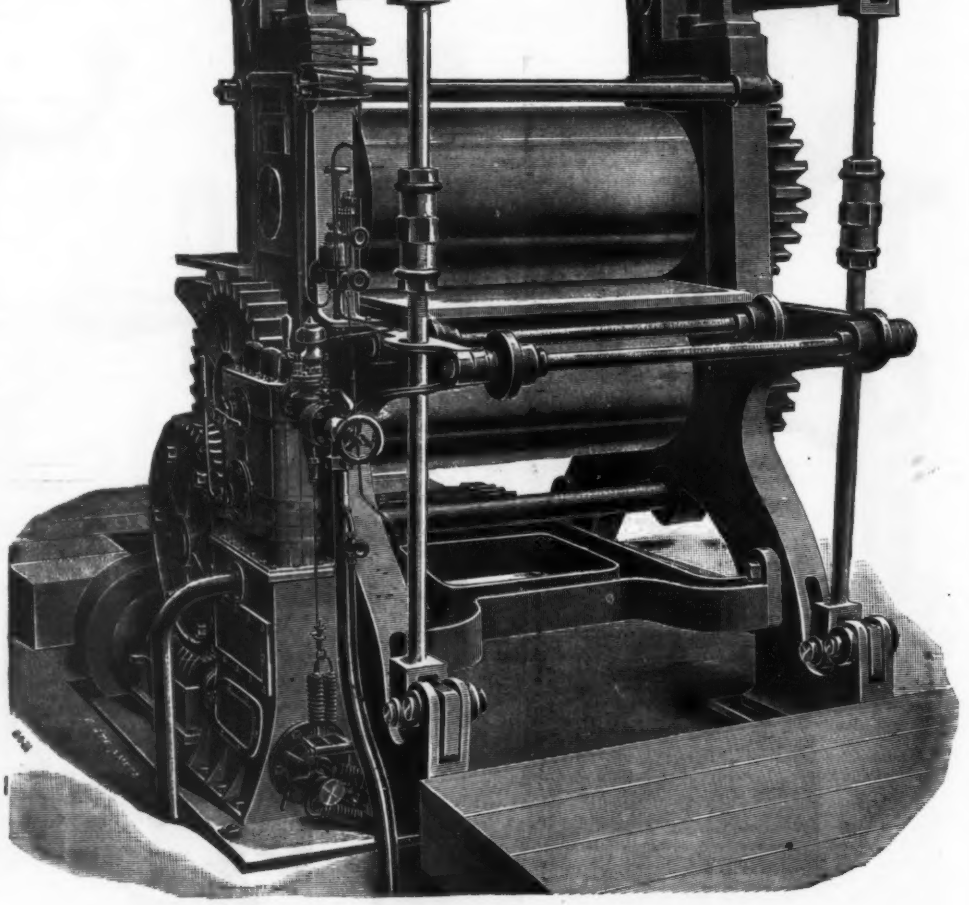
With the hand presses it is necessary to damp and scrub the surface of the paper in order to obtain sharp impressions. But the impressions taken on damp paper have the great disadvantage that on drying, the paper not only shrinks considerably, but what is worse, the contraction is not uniform, nor is it the same in the length of the sheet of paper as it is in the width. The copper plate, however, is true to scale; it follows, therefore, that the impression will not only be too small, but it will also be distorted; and, further, this shrinking and distortion varies with each impression. Owing to the large size of the 6 in. engraved maps, this shrinkage, etc., is very apparent, and it is for this reason that these maps are printed from transfers to zinc.

A better way of getting over the difficulty is to print on dry paper, but to obtain a good impression a far greater pressure is needed, and some preliminary experiments showed that with copper plates $26\frac{1}{4}$ in. wide (those on which the 6 in. maps are engraved) a pressure of forty tons would be necessary. This pressure being too great for the hand presses in use, it was decided to obtain a press capable of working easily at this pressure, and driven by steam.

The general arrangement and construction of the press will be seen from the illustration. Its design and manufacture were intrusted to Messrs. Furnival & Co., Reddish Iron Works, near Stockport, and it can be shortly described as follows:

The two side frames are secured by a massive cast iron cross frame placed near the feet, as well as by two wrought iron tie rods of 2 in. diameter, fixed near the top. The two printing rolls are each 1 ft. 6 in. in diameter, and 3 ft. long, and are placed one over the other; they are made of chilled cast iron, accurately turned and then ground dead true and perfectly smooth on a special grinding machine. The printing table works between the rolls, and is made of rolled steel, 6 ft. long, 3 ft. wide by 1 in. thick, and is accurately planed and surfaced. Small runner pulleys are fixed to the frame sides, to support the table in its to-and-fro movement. The bearings of the top roll are placed in boxes, which can slide vertically in slots in the side frames, and the pressure is obtained by means of a couple of compound levers and weights. The weights can easily be altered, and the pressure thus varied to any desired extent up to forty tons.

The rolls are geared together with two cast iron wheels of specially strong metal; the teeth are $2\frac{1}{2}$ in. pitch, and are cut out of the solid. On the other end of the bottom roll is fixed a wheel of thirty-four teeth, 2 in. pitch, which gears to a pinion of eleven teeth, 2 in. pitch, made of hammered iron, also accurately turned and cut out of the solid. This pinion is keyed to a steel shaft, which has bearings in both side frames. On this shaft is also keyed a wormwheel of fifty teeth, $1\frac{1}{2}$ in. pitch, the rim of which is made of phosphor bronze; the boss is of cast iron, and the rim and boss are bolted together with steel bolts driven in. The teeth in the wormwheel are cut to a true shape by a special hob of the same size as the worm, insuring that the worm and wormwheel will work together without back lash, and bringing the greatest amount of wearing surface of the worm into use.



COPPER PLATE PRINTING MACHINE.

The worm itself is cut out of the solid in the middle of a steel shaft (which also carries a small fly wheel), one end of which rests in a thrust bearing fixed to the foot of the side frame, the other end being coupled to the engine. The worm runs in an oil box covered over to prevent the oil splashing about.

The engine selected for driving the machine was a Willans three-tandem compound reversing engine, coupled direct to the press, the speed being reduced by means of worm gearing. This selection was made because of the extremely satisfactory working and marked economy in steam consumption of four other Willans engines at work on the Ordnance Survey, together with the very small space occupied.

The Willans engine is too well known to need description. It may, however, be mentioned that the one now under notice was the first reversing engine of the three-cylinder type fitted with guides acting also as "air cushion cylinders." These have been used in all the later types of the Willans engines, as made by Messrs. Willans & Robinson, when employed for land work, such as electric lighting or driving machinery, but they have only lately been applied to the reversing or marine type. The engine is capable of developing 9 indicated horse power when working at 720 revolutions per minute, with 120 lb. steam pressure, but it is governed by a Willans centrifugal governor, adjusted for only 500 revolutions. This still high speed is reduced by gearing to only $3\frac{1}{4}$ revolutions per minute of the rolls, equivalent to a surface speed of about 17 ft. per minute. The press and the engine are firmly bolted down to large stones bedded in cement concrete.

The engine, and consequently the press, can be started, stopped, reversed, and stopped again with the greatest ease, and almost instantaneously. The whole arrangement works with the utmost smoothness, and without any noise.

When, as in the present case, a press of this kind requires a separate engine to drive it, a small high-speed engine, connected by worm gearing to the press, is advantageous as regards space, and, moreover, the handiness of the arrangement is very great. As an experiment it was found possible to put the press through the following cycle, namely, from a state of rest: start, stop, reverse, stop, start, stop, thus coming back to the original position in less than three seconds. This was, of course, done without the bed passing the full distance to and fro. This arrangement is also economical in that the engine is only running when work has to be done, which probably more than compensates for the loss of power due to the worm gearing. It should be noticed that a closed engine like the Willans prevents any chance of oil flying about and damaging the impressions.

The press has more than realized all expectations, and dry impressions, quite as sharp and distinct as damp impressions, have been obtained from copper plates measuring $38\frac{1}{4}$ in. by $26\frac{1}{4}$ in. But it was found that perfectly dry impressions erred in the other direction, and came out, as the result of such heavy pressure upon the paper, about $\frac{1}{16}$ in. too long. The effect of very slightly damping the surface of the paper, just before printing, was therefore tried, and excellent impressions were obtained with less pressure than was previously required for dry impressions, but these were as much too short as the dry ones were too long.

A better means of regulating the damping of the surface of the paper by sprinkling with water just before printing is now being devised, and it is hoped that it will then be possible to obtain impressions exactly the same size as the copper plate.*

In any case, the improvement already effected is very great, for with damp paper, as used in the ordinary hand presses, the shrinkage averages $\frac{3}{4}$ in., and often amounts to 1 in., and is, moreover, irregular, varying from one sheet to another.—*Engineering.*

MACHINES FOR BEATING CARPETS.

It is customary in large cities to take up carpets in the summer season, and to intrust them to special houses, which make it their business to beat and store them. The beating of carpets is an operation that is at once laborious and unhealthy, and for which an endeavor has been made to substitute mechanical action. Now it seems of interest to show what has been proposed in this line, although up to the present the use of machines has not become general.

Our researches among patents applied for in France for these kinds of apparatus have led to the discovery of those that follow:

* Since writing the above the method of printing on "sprinkled" paper has been so far perfected that impressions with practically no shrinkage can be obtained. Owing to this result and to the fact that sharper and cheaper impressions can be printed direct from the copper, transferring to zinc has been abandoned for the 6 in. maps.

Salomon and Jasmin (Nov. 25, 1879).—Machine for beating and cleaning carpets and other fabrics.

Figs. 1 and 2 show the arrangements of this machine, in which the carpet, instead of presenting itself vertically to the action of the rods, travels horizontally, being carried along by an endless belt, A, which passes over three rollers, *a*, *b*, and *c*, the former of which is rotated slowly by the pulleys, *d* and *e*, and the latter, *c*, serving as a stretcher.

The beating mechanism, which is supported by two brackets, B, fixed to a beam, is independent of the frames that support the belt and the axles of the two brushes, C and C'.

The cam shaft, D, revolves in bearings on the brackets, B, and which are so arranged as to serve at the same time as a support and center of oscillation to the branches, E, which, at their lower part, carry the shaft, F, of the beaters and terminate beneath in toothed sectors that engage with pinions, *g*, fixed to the axle, G. On revolving this axle by means of the handles, *g'* (Fig. 2), the branches, E, may be inclined, and the position of the beater shaft with respect to the belt be regulated. Upon the shaft, G, there are arranged at equal distances, so as to correspond to the cams, levers with two branches at right angles. These levers are mounted loosely so that they can be actuated independently by the cams, which, to this effect, are arranged spirally on the shaft, D.

To the horizontal branch of each of these levers is screwed a beating rod, F', and behind the vertical branch there is a spring, *h*, which, as soon as the cam abandons this branch, after thrusting it backward, pushes it abruptly forward so as to cause the rod to strike the fabric. In order to prevent too long a contact, the spring is bent at its other extremity so as to act under the horizontal branch of the lever in order to separate the wool and allow the blower, E, through a groove, *e*, of small section, to project a blast of compressed air in order to force out the dust lodged in the bottom. For certain fabrics this blower may be replaced by a strong rotary brush, as shown by the dotted circles, *e'*.

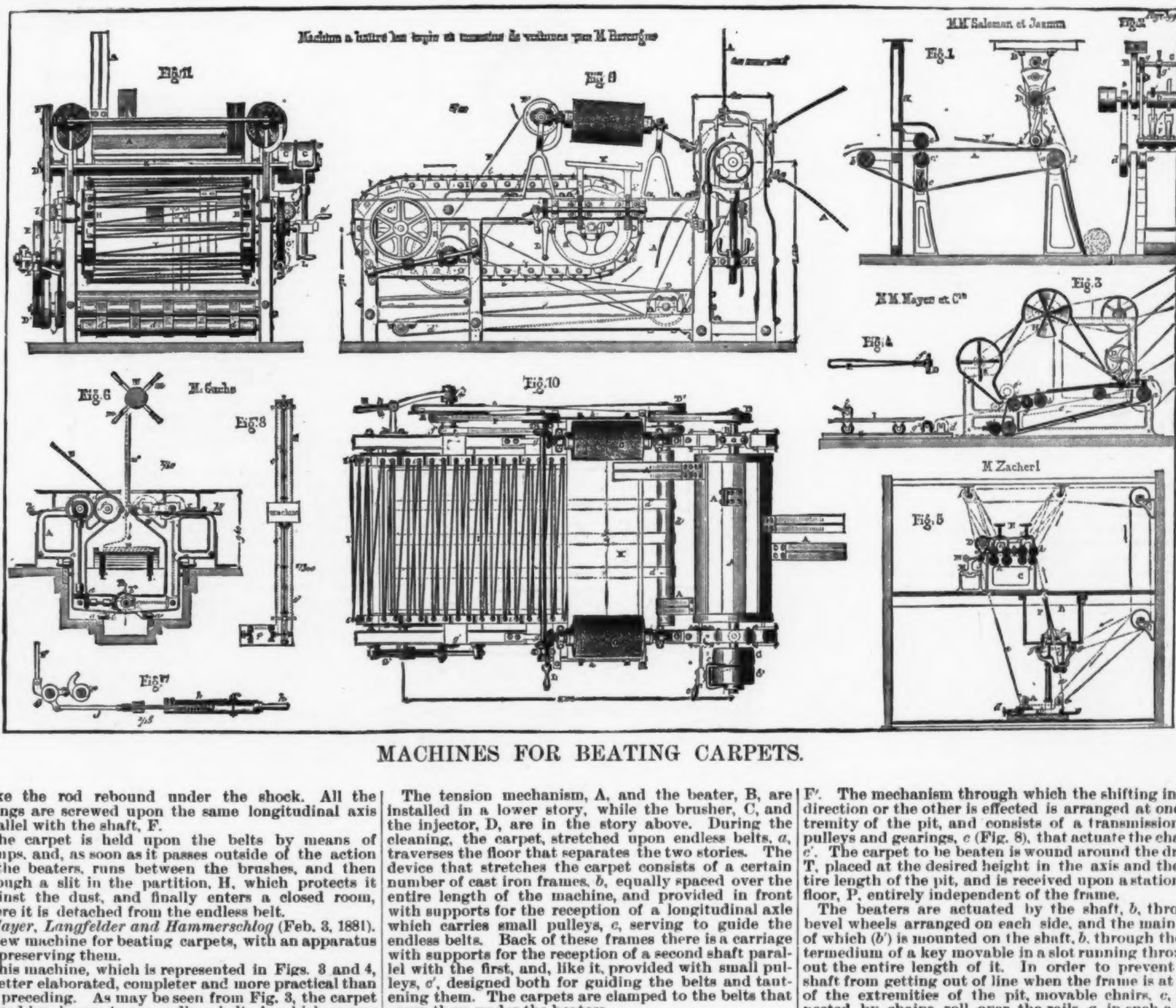
In all cases, the carpet is constantly cleaned upon its two faces by the brushes, *g* and *g'*. These latter, as well as the cylinder, *d*, can be moved to *g'* and *d'* in bearings which, mounted upon the rails, G, can be made to advance or recede according to the length of the carpet when the latter is out of proportion to the dimensions of the machine.

Between the beater and the blower, the base of the machine is closed by light boards forming a sort of funnel terminating in a screen, H, with inclined vanes, which suck up the dust and carry it outside at one of the extremities.

The beaten and brushed carpet is detached from the belt, A, and wound up on the carriage, I, by passing one of its extremities through a slit in the roller, *i*, which is turned with a winch. In this way all abnormal traction is avoided.

Zacherl (Nov. 19, 1881).—Improved method and apparatus for cleaning carpets and other fabrics.

This method consists in passing the carpet vertically between two rows of beaters, so that it shall be beaten on its two surfaces at the same time. The vertical position is adopted in order to facilitate the fall of the dust and prevent it from settling back upon the carpet. The dust is forced into a conduit by a blower. The carpet is afterward brushed upon its two surfaces by a completely distinct system of brushes. Fig. 5 shows the apparatus as a whole. It consists of four distinct parts—a tension mechanism, a beater, a brusher, and an injector.



MACHINES FOR BEATING CARPETS.

make the rod rebound under the shock. All the springs are screwed upon the same longitudinal axis parallel with the shaft, F.

The carpet is held upon the belts by means of clamps, and, as soon as it passes outside of the action of the beaters, runs between the brushes, and then through a slit in the partition, H, which protects it against the dust, and finally enters a closed room, where it is detached from the endless belt.

Mayer, Langfelder and Hammerschlag (Feb. 3, 1881).—New machine for beating carpets, with an apparatus for preserving them.

This machine, which is represented in Figs. 3 and 4, is better elaborated, completer and more practical than the preceding. As may be seen from Fig. 3, the carpet is fixed by clamps to an endless belt, A, which passes over five rollers, *a*, *a'*, *b*, *c*, and *d*. Motion is communicated by the roller, *a*, above which there is a flat brush, B, arranged to move laterally so as to free the carpet of the light dust that adheres to it before the action of the beater. This brush serves also to open the meshes of the fabric, which are often choked up by humidity.

The beaters consist, as shown in Fig. 4, of curved elastic rods, F (rush, hard rubber, or flexible metal), each fixed separately in the socket of a bent lever, *f*, the perpendicular branch of which is actuated by means of the cam shaft, D. When the cam frees it, the beater is abruptly lifted by a spring.

For regulating the force of the beating, the springs are provided at their base, and at each extremity of their support, with adjusting screws, by means of which the desired tension is given. The same is the case with the brush, B. During the beating, the dense dust passes through the carpet and falls into the receptacle, C, which extends the entire length of the machine.

The beaten parts of the carpet, on moving forward, pass over the fluted rotary cylinder, *e*, whose semicircular edges are covered with gutta percha, in order to separate the wool and allow the blower... The tension mechanism, A, and the beater, B, are installed in a lower story, while the brusher, C, and the injector, D, are in the story above. During the cleaning, the carpet, stretched upon endless belts, *a*, traverses the floor that separates the two stories. The device that stretches the carpet consists of a certain number of cast iron frames, *b*, equally spaced over the entire length of the machine, and provided in front with supports for the reception of a longitudinal axle which carries small pulleys, *c*, serving to guide the endless belts. Back of these frames there is a carriage with supports for the reception of a second shaft parallel with the first, and, like it, provided with small pulleys, *c'*, designed both for guiding the belts and tautening them. The carpets are clamped to the belts that carry them under the beaters.

The latter consist of two rows of rods, F, mounted on levers, *f*, whose axes revolve in bearings fixed at T, upon the iron cross pieces, G, which, supported by columns, serve as a frame to the machine.

Motion is communicated to the beaters by cam shafts, *g*, which act upon a projection at the extremity of rods that are attached to the horizontal branch of the levers, *f*, and are provided with springs that keep them always raised. As soon as a cam comes into contact with one of these projections or pawls, the corresponding beater is lifted from the carpet and the spring is compressed; and when the cam frees the pawl, the spring abruptly expands, and the beater strikes the carpet.

As shown in the figure, the beaters are inclosed in a box, B, which prevents the dust from escaping to the exterior. The sides of this box are provided with glass windows to permit the work to be watched. On one side, the box communicates with a conduit, and, at the opposite side, air is introduced through a panel.

When the carpet leaves the beaters, the belts, *a*, which traverse the floor and pass between the guide rollers, *i*, *i'*, and *j*, bring it under the action of four cylindrical brushes, *k* and *k'*, which act in pairs upon each surface and directly over and above, the guide rollers, which latter thus serve as a support to the carpet while it is being brushed. The axles of the rollers, *i*, and of the brushes, *k*, of the lower row are supported by a cast iron frame fixed to the floor, and those of the upper rollers and brushes, *i* and *k'*, by another frame suspended from the beams, E.

After it has passed under the brushes, the carpet runs under a hopper, *l*, surmounted by a cylinder, D, which contains a sieve of polygonal section that holds insect powder and has a slow rotary motion. This motion causes the powder to fall into the hopper, *l*, which itself has an oscillatory motion to facilitate the descent, and distributes the powder in small quantities over the entire surface of the fabric.

The carpet, after it has been thus cleaned and injected, is wound around the roller, *m*, which is supported by the cast iron frame, M, and is revolved through a winch.

Gache (June 12, 1882).—Improvements in machines for beating carpets and other fabrics.

In this machine, the carpet passes vertically between two rows of rods, which alternately whip its two surfaces. The first machine described in the application for a patent, although giving good results, permitted of operating only upon narrow carpets, thus obliging the inventor to make some modifications in it. Fig. 6 shows this new machine in transverse section, and Fig. 8 gives a plan of the general installation.

It will be seen that the frame, A, which carries the entire beating arrangement, is mounted upon rollers, *a*, in order that it may be shifted longitudinally over the pit, B, at the bottom of which is placed the main shaft, *b*, that transmits motion to the beaters, F and F'. The mechanism through which the shifting in one direction or the other is effected is arranged at one extremity of the pit, and consists of a transmission by pulleys and gearings, *c* (Fig. 8), that actuate the chains, *c'*. The carpet to be beaten is wound around the drum, T, placed at the desired height in the axis and the entire length of the pit, and is received upon a stationary floor, P, entirely independent of the frame.

The beaters are actuated by the shaft, *b*, through bevel wheels arranged on each side, and the main one of which (*b'*) is mounted on the shaft, *b*, through the intermedium of a key movable in a slot running throughout the entire length of it. In order to prevent the shaft from getting out of line when the frame is at one of the extremities of the pit, movable chairs, *e*, connected by chains, roll over the rails, *a*, in such a way as to distribute the bearing points over the entire length of the shaft.

The shafts, *f* and *f'*, actuated by the transmitting mechanism, which consists of cog wheels and bevel wheels, *d* and *d'*, that revolve continuously, are provided with cams that act upon rollers held by cheeks cast in a piece with the sockets, *g*, in which are fixed the beaters, F and F' (Fig. 7). The cams are arranged spirally on the shafts, *f* and *f'*, so that the beaters may not all strike at once.

To regulate the force of the blows, the workman has only to draw the tube, *h*, more or less through the aid of the handle, *h'*, and to stop it in the desired position with the pin, *i*, which engages in one of the holes formed for this purpose in the tube. This has the effect of compressing or freeing the spiral spring, *r*, and, as the latter is connected by the rod, *j*, with the socket, *g*, its greater or less tension permits of modifying the action of the corresponding beater.

The drum, T, which receives the carpet to be beaten, is provided with handles, *m*, to permit of its being easily revolved.

Machine for Beating and Brushing the Carpet Cushions of Railway Cars.—In its common elements, this machine consists of a solid frame formed of two cross-braced wooden uprights which support all the parts. These are, in the first place, the slide bearings, B, designed to receive the axle of the open drum, A, 20 inches in diameter, on the circumference of which are fixed the beaters, A', formed of 12 strips of sole leather in pairs. The height of the bearing, B, is regulated at will by means of two screws, *a*, and nuts, *b*. Motion is transmitted to the drum by the pulley, C, at a velocity of 300 revolutions per minute. Alongside of this fast pulley is mounted a loose one, C', to which the belt is transferred by the shifter, *c*, when it is desired to stop the machine. The other extremity of the drum shaft is provided with a pulley, D', which, through a belt, sets in motion a double pulley, D', mounted loosely upon the axis of a roller, *d*, whose bearings are fixed upon the lower part of the frame. This roller is designed to receive the straps, *d'*, for the return of the carpet.

Through a crossed belt, *e*, one of the pulleys actuates the double pulley, E, which is mounted loosely at the extremity of an intermediate shaft by means of which the other parts of the machine receive motion, while the clutch box, *e'*, which is maneuvered with a lever, E', is geared with this pulley. The motions transmitted by this intermediate shaft are as follows: Through the small pulley, *f*, and the one, *f'*, it actuates the roller, *d*; through a belt, F, it drives the pulley, F', whose axle, through two pairs of bevel wheels, *g*, actuates the two brushes, G; finally, through a pinion, *g*, fixed to its other extremity, it sets in motion a similar pinion keyed upon a small inclined shaft (Fig. 9) provided with an endless screw that gears with a wheel, G', with helicoidal teeth, which is keyed upon the axle of the forward tumblers, H, that carry the endless chains, I, which pass over the back tumblers, H'. These chains are formed of blocks of wood hinged together and connected by iron cross pieces. A very taut cord, I', completes this chain, which carries the carpet under the beaters. The cushions are at once beaten and brushed, and are, to this effect, placed upon the table, K, whose height can be regulated at will, according to the thickness of the cushions, by means of a double rack mechanism, which consists, on each side of the frame, of a shaft, *k*, provided with two pinions that gear with the racks, *k'*, and are actuated by means of the handle, L, whose transverse axis carries two small wheels with helicoidal teeth that gear with two similar wheels, *l*, fixed to the extremity of each of the shafts, *k'*, in such a way as to set them in motion simultaneously. Each cushion is whipped four times in the space comprised between the two brushes—twice on the right side and twice on the reverse. The cushions are pushed one by one on to the table, K. The brushes revolve in opposite directions, so as to collect the dust in the center, whence it is removed by an aspirator.

The brushes are not used for carpets. The belt, F, which actuates them is removed, as is also the table, K, and the height to be given to the drum, A, is then regulated. The carpet is placed upon the cords, I', and advances toward the beaters in the direction shown by the arrows (Fig. 9), and is then carried by the endless belts, *d'*, to the feet of the workman.

The machine is inclosed in a chamber ten feet in length, six feet in width, and seven feet in height, which protects the workman against dust, and which is provided laterally and above with glazed frames in order to permit of watching the work done by the beaters.

In measure as dust is produced, it is removed through three suction orifices, two at the top of each end of the chamber and the other near the floor at the right, all three communicating with a Burdon aspirator placed outside.

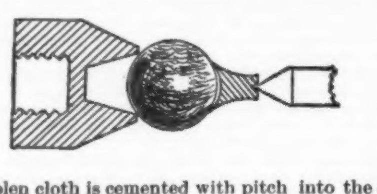
The capacity of this machine is 300 carpets or cushions per day of ten hours, with two workmen to run it. —*Publication Industrielle.*

[ENGLISH MECHANIC.]

HOW TO TURN A SPHERE.

FOR the purpose of turning small spheres in which perfect accuracy is required, spherical chucks are but of little value except for the purpose of roughing out the material to shape previous to a final corrective and finishing process of scraping or grinding and polishing.

Turning a sphere is a simple and easy operation with any ordinary lathe, no special tools being necessary. In metals that can be melted the balls are cast, several together in lengths, and sawn asunder; but for iron or steel the balls are roughed out from the rod to a segment template, and then separated. Turn out a taper hole in a pewter or boxwood chuck, rather less than half the diameter of the intended sphere; the rough ball is jammed in this by the shifting center, interposing a cupped piece of metal, preferably of steel, as a guard to prevent contact of the center against the ball, as shown by the cut. Set the T rest high, or rather above the center, and with a sharp graver used overhand shave down all the prominent parts till a zone on the ball, a shade larger than the finished size, runs quite true, then slack the center and twist the ball half round, so that the zone just turned is in the line of centers. By cutting round right and left down to this circle a great step is made toward accuracy. Again shift the ball as before, and continue the operation till the graver, by touching every part, will only take a faint scrape equally over all the surface. The edge of the chuck should be trimmed perfectly true toward the finish. If the ball is liable to slip under the cut, the edge may be touched with resin. The ball, though now quite accurate, has not a fine polish, but appears scraped over with segmental scratches intersecting each other in every direction. In order to produce a final polish, a "sphere cutter" should be used. This is a tubular piece of steel or ferrule, hardened, having a bore ranging from half to two-thirds the diameter of the sphere. Exact size is of no consequence. After this is hardened the inner edge should be ground out with oil stone dust to a true circle on a brass or metal cone to fit, and the square end cutting edge is kept sharp by rubbing it on a flat lap with fine emery. This ferrule, if of large size, is driven on to a short wooden handle; but the small sphere cutters consist merely of a piece of rod steel, with a hole drilled in the end. A light touch with this tool with a slow lathe speed will give a fine polish to the ball, which is then finished. The action is rather a scraping than a cutting one, and if the ball is of steel, soapsuds should be used. If the steel balls are hardened, they are sure to suffer slight distortion, to remove which they must be ground true by means of a clam made of a rod of metal of suitable size bent like a pair of sugar tongs, having an eye drilled at the extremity of each arm, into which the stems of cup-shaped pieces of lead are riveted; the arms of the clams are closed on the ball by a long screw tapped into one of them, or by a winged nut, as in a hand vise; the ball is shifted about frequently as in turning, and the clam is twisted to and fro, using oil stone dust or fine emery till the ball is *felt* to be quite true. If a brilliant polish is required, a wad of



fine woolen cloth is cemented with pitch into the cups of the clam, and charged with crocus and water.

The above method may appear to be slow and tedious, but after a little practice it is really not so. I have turned spheres from 2 in. in diameter (for the clacks of feed pumps) down to steel balls of less than ¼ in. both easily and expeditiously, as there are no troublesome adjustments or chuckings to be attended to. F. H. WENHAM.

I append sketches, which I will briefly describe, and then give the method of procedure. A (Fig. 1) is a chuck made of same material as that which is to be turned, and screwed on lathe mandrel. The section shows it to be a hollow cylinder, allowing a bearing on sphere of about ⅜ in. or ¼ in. C is a small piece of metal holding ball in chuck between centers. The center next to ball is much larger than that at poppet center. D is poppet center. A and B are plan and elevation of a tool used for finishing process. It may be made of a piece of cast steel tubing, bored or lapped a perfectly true circle, *i. e.*, for practical purposes. It should be from $\frac{1}{16}$ in. to ¼ in. thick, and marked with circles on the outside, the distance apart being equal to the thickness of the shell. These lines will be a guide to the grinding of the tool, which should have a bevel of about 45°. A wooden handle may be knocked in about 10 in. long. Arrange the sphere as in Fig. 1, and turn up with an ordinary turning tool, reversing the sphere as convenient. With a diamond pointed hand tool take out the tool marks from last process, leaving the ball about $\frac{1}{16}$ in. larger than the finished size. For small spheres—1 in. and less—this tool must be ground to a point; but for larger sizes it may be slightly rounded at the point. Now take the tool (Fig. 2), and work around one hemisphere, always taking care that the tool does not get in the same straight line as the lathe centers. The cutting edge of the tool should be at right angles to the bore of this tool, and its diameter should not be more than three

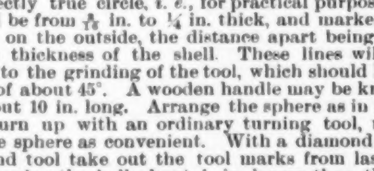


FIG. 1

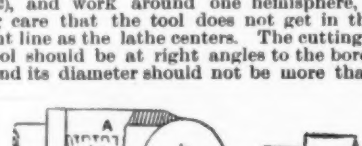


FIG. 2

quarters the diameter of the finished sphere. The chuck in Fig. 1 should not cover more than half the sphere, thereby allowing a hemisphere to work upon at once. The poppet head may be pushed away for the finishing process, the cup tool being sufficient to hold the ball in the chuck.—WILLIAM HY. RUSSELL.

CHEMICAL REAGENTS FOR TEXTILE FABRICS.

VARIOUS reagents are now in use for the identification of the materials employed for the manufacture of textile fabrics, and recently the processes for the rapid detection of the presence of animal fibers in vegetable tissues and the converse have been much simplified. Animal fibers can be primarily distinguished from those of plant origin by their solubility in strong soda or other alkaline solvent, while the mineral acids char vegetable fibers, and have little or no action upon those derived from animals. Silk and cellulose are soluble in the blue ammoniacal copper solutions, from which the silk is reprecipitated by dilute acids, and the cellulose by several salts. Schlossberger uses a solution of nickel oxide in ammonia for dissolving silk mixed with cotton, in which the latter is insoluble. Nitric acid also dissolves silk, and colors wool and all animal fibers yellow. A mixture of mercuric and mercurous nitrates, for a long time known as Millon's reagent, has also the property of turning fibers of animal origin a red color. As wool contains a small but constant quantity of sulphur, the blackening of a solution of litharge in a caustic alkali identifies the presence of this substance. Silk, however, is occasionally sulphured, and will then give a similar blackening with this reagent. The amount of silk present in a sample of cloth can be estimated by a method which is based on the fact, first observed by Persoz, that it differs from other textile materials in being readily soluble in a hot and strong solution of chloride of zinc. The method of procedure is as follows:

The dressing is removed by a preliminary boiling in dilute hydrochloric acid, and, after washing, the cloth is immersed in a bath of the chloride of zinc solution, which is prepared by dissolving one hundred parts of chloride of zinc, together with four parts of the oxide, in eighty-five of water. The loss of weight after washing and drying gives the quantity of silk present in the material.

The amount of wool in the same material can also be determined by taking a fresh quantity, and noticing in a similar manner the loss of weight after it has been heated to 212 degrees Fahrenheit for a quarter of an hour in a solution of caustic soda of sp. gr. 1·02. Hoehnel has noticed that mulberry and wild silks behave differently when treated with a solution of chromic acid. Wool and mulberry silk dissolve rapidly in this solvent, while wild silk is only slowly acted upon. Boiling hydrochloric acid dissolves silk rapidly, while any wool present in the fabric increases in bulk, but does not dissolve. This method is also used as a means of determining quantitatively the relative amounts of these fibers in a fabric. If a mixture of wool, cotton, pure and wild silk be present, hydrochloric acid dissolves the mulberry silk first, and finally the Jamamai silk, while the wool is dissolved from the unaltered cellulose by means of a solution of caustic soda. Molisch's method for distinguishing between animal and vegetable fibers was recently alluded to in these pages. It is based on the fact that cellulose, when warmed for some time with a mineral acid, yields a small quantity of sugar, which can then be recognized by the addition of a solution of naphthol or thymol in alcohol, mixed with an equal volume of concentrated sulphuric acid. Naphthol, under these conditions, gives a deep violet coloration, and thymol a vermilion tint, if vegetable fibers were present in the original cloth. Sidoff has also noted that silk is dissolved by fused oxalic acid, while cellulose (cotton) only disappears on prolonged treatment. Wool is not attacked by this reagent. Lastly, the behavior of various dyestuffs, *e. g.*, magenta, toward the different materials present, often affords a convenient means of identifying the substance used in the manufacture of the fabric.—*Industries.*

GAS LIGHTING AND DUST.

IT is generally admitted that one of the most annoying and troublesome of the drawbacks to gas lighting in living rooms is the deposit of dirt on the ceiling over the flames. So far no real cure of this nuisance has been attainable, although it must often have occurred to householders to wish, after their ceilings had been nicely washed and colored, that the gas used to light the rooms would permit them to remain clean. Time was when this trouble was believed to arise from sootiness of the gas, and the elimination of this quality was a favorite pursuit of the uninstructed inventor of gas burners. Although this well known personage, with perseverance worthy of a better cause, may yet be engaged in his elusive task, people who have really investigated the question know now that the trouble of grimed ceilings is not due to anything in the gas itself that can be removed by any process of filtration or purification. It is generally accepted to be due to the burnt dust of the atmosphere, carried up with the current of moist gases rising from a gas burner, as from any other center of combustion, and stuck on to the ceiling. The plaster being porous between the laths, a process of exosmosis goes on, the rarefied air lying immediately underneath the ceiling passing through the plaster, and being replaced by cold air from the space above it. As the heated air which escapes in this way cannot take its burden of dust with it, the latter remains behind; and thus, in a dirty ceiling of a gas lit apartment, the lathing is plainly defined by lighter lines upon the more permeable portion of the plastering. We have briefly repeated this well understood explanation of the phenomenon of dirty ceilings, in order to call attention to the important part played by dust in conjunction with gas lighting. Of course, gas burners are not the only sources of ceiling contamination. They are usually the most powerful of centers of combustion exposed in the atmosphere of living rooms; and the currents of hot dust-laden air which they send up to the ceiling are consequently more considerable than those which rise from lamps or candelabra, whereas the dirt from gas burners is really brownish in color. Moreover, the ceiling of a room lit by lamps or candles slowly but surely grows black from actual soot resulting from imperfection, flaring lights due to draughts, etc. The time required to darken a ceiling at a given height above a gas flame depends on the average dustiness of the atmosphere. In a dirty town the effect is quickly produced; while in the country the same gas would be almost free from this reproach.

The study of the dust, which is an invariable accompaniment of atmospheric air, is therefore a matter of some interest in relation to the problem of domestic lighting, although not to such a degree as in connection with sanitation and meteorology. From its importance in regard to the latter subjects, it might be said with truth that the elemental constitution of air, which is usually given as consisting of a mixture of oxygen with nitrogen and a little carbonic acid gas, should be amended by the inclusion of dust. The researches of Mr. John Aitken and others who have devoted themselves to this line of inquiry have already proved that dust is of vastly greater importance, taken as an element in the composition of air, than is the much more regarded carbonic acid. The variation of the proportion of carbonic acid in the air of town and country is so slight that any one disposed to take an exclusively chemical view of the question might be excused for thinking that one is as good for man as the other. Contemplation of the possible influence of dust upon the human organism—especially when complicated by considerations arising out of the germ theory of diseases—materially alters the case; and it does not require a deep philosophic insight to perceive that, all things being equal, air that is freest from dust must be preferable for most human requirements.

The influence of dust particles in the air upon the formation of fogs has been well demonstrated by Mr. Aitken, who has gone further, and shown that the formation of rain drops is due to the condensation of moisture on dust nuclei. Pursuing his researches, Mr. Aitken conceived the idea that if the dust particles in the air could be counted, a valuable guide to the causes of many phenomena connected with the atmosphere might be procured. It is unnecessary, and would be outside our purpose, to relate

how Mr. Aitken set about this apparently hopeless task. His method is described in a paper read to the Abstract Society of Edinburgh, and published in *Nature*. The results so far obtained go to show, in a very striking manner, the almost inconceivable number of dust particles that exist in the air we breathe and burn. After a wet night, on Jan. 25—at a season and time of day when dust must be expected to be scarcest—a sample of air taken from outside the house contained 521,000 particles in a cubic inch; and when the weather was fair, the outside air gave 2,119,000 particles to the cubic inch. Indoor determinations showed, as might be expected, an enormous preponderance of dust. Thus a sample taken, in a room where gas was burning, at a height of 4 feet from the floor, contained 30,318,000 particles per cubic inch; air drawn from near the ceiling of the same room, 88,346,000 particles per cubic inch; and the air collected over a Bunsen gas flame, no less than 489,000,000 particles of dust per cubic inch. These latter determinations are the most interesting from our point of view. Mr. Aitken admits that the numbers "do seem very large;" but although he does not pretend to have attained absolute accuracy, he declares that they may be trusted as fairly correct and at least represent the kind of numbers with which experimenters in this line have to deal. If anything, he believes that they are under rather than over the mark, owing to the difficulty of handling dusty air without losing some of the particles. He confesses that it seems strange that "there may be as many dust particles in one cubic inch of the air of a room at night when the gas is burning as there are inhabitants of Great Britain; and that in three cubic inches of the gases from a Bunsen flame there are as many particles as there are inhabitants in the world." This is a capital statement for a lecture; but of course it does not elucidate the question much in the eyes of a student.

The most important part of the problem seems to be what is the reason of the enormous increase in the number of dust particles apparently produced by an atmospheric gas flame? We confess that this part of Mr. Aitken's disclosures appears to be the most difficult of all to comprehend. One can understand what sort of dust he had to deal with in the samples taken from a street or a room; and is not surprised to learn that in the latter case they are very much more numerous. What kind of dust is it, however, that is so plentifully produced by a Bunsen gas burner? It cannot be the same as the other samples, because the latter could not remain unaltered in the heat of the flame. Are we to alter our opinion respecting the cause of the blackening of ceilings over gas flames, and regard the flames as positive manufactories of dust? It is difficult to accept such a conclusion; and we are compelled in preference to incline to the opinion that, in Mr. Aitken's experiments, products of combustion must have somehow imitated the behavior of solid particles of dust. We are the more disposed to take this alternative, although it is not so much as hinted at by Mr. Aitken, from something the same experimentalist is known to have said with regard to the prospect of abolishing town fogs by preventing smoke from coal fires. Mr. Aitken has ventured to make the statement, in opposition to the orthodox smoke preventionists, that, even if coal could always be burnt smokelessly, the worst characteristics of fogs would still be presented, because the sulphurous acid of the coal would have the same condensing effect as solid particles of carbon upon an atmosphere surcharged with moisture. At least, this is the substance, if not the precise wording, of his contention. He seems to have forgotten it, however, in commenting upon the result of his latest examination of the products of combustion of gas. The point is the more remarkable, as it has always been understood that to burn air is a way to free it from dust particles. The experiment has been shown thousands of times with a magic lantern and a spirit lamp. The classical idea upon the subject is therefore widely different from that propounded by Mr. Aitken; and the onus of proof that he is right lies upon him. It is clear enough that the phenomenon of ceiling darkening, which means the arrest by the plaster surface of countless millions of dust particles, is quite consistent with the presence at any time of no more dust in the ascending current of air from a center of combustion than exists in the other parts of the room. It is the steady direction of the current upon one spot for many hours that produces the observed effect. That the current itself contains more dust than any other current of the same air which might be created by other means than a flame is, however, a debatable question.—*Jour. of Gas Lighting.*

THE GREAT TELESCOPE AT NICE.

ASTRONOMICAL SOCIETY.

PARIS, Feb. 1.—M. Flammarion, president, in the chair. M. Flammarion expressed his admiration of what he had seen at the Nice Observatory on a recent visit. In the great equatorial (30 inches aperture), the Orion nebula is splendid, stars of the sixteenth magnitude seem bright, and double stars from 0"·1 to 0"·3 apart are discovered. M. Flammarion observed the lunar eclipse on January 28 at Nice. The moon remained easily visible during totality, and of a bright copper hue. The Nice Observatory is 375 meters above the level of the Mediterranean Sea. In the finder of the great equatorial the shadow was fringed with a transparent border about 2' in breadth. MM. Henry Brothers and M. Trouvelot remarked the contrast this eclipse presented with that of October, 1884, in which the moon nearly disappeared. M. Detaille said that he had been struck by the very fine color of the moon; the earth's shadow, though ill-defined on the edge, was quite circular. MM. Henry showed a photograph of the Pleiades taken with their 34 centimeter object glass, and an exposure of four hours. The negative included stars down to the seventeenth magnitude. Much new nebulous matter is discovered in this photograph. One of the bright stars is enveloped in a dense nebula hitherto unseen. Several singular long thin streaks of nebulous matter extend in some cases from star to star to a considerable length. M. Berteaux, geographical editor, presented the society with a new map of the moon by M. C. Gaudibert, the well known selenographer. This map has been made from M. Gaudibert's observations and revisals; it has been drawn by M. Tenet, and reproduced by heliography. The diameter of the disk is 64 centimeters.

HUSBAND'S PROCESS OF PHOTO-LITHOGRAPHY IN HALF TONE.

THE main factor in the production of the grains is common salt, added to the gelatinous mixture with which the paper is coated in the first instance, while the same salt, and also ferricyanide of potassium, are added to the sensitizing bath.

The details of the method, as given in the Journal of the Photographic Society, are as follows:

Any good surfaced paper is floated on a bath composed of:

Gelatine (Nelson's flake)...........	8	ounces.
Glycerine........	1½	ounce.
Chloride of sodium (common salt).	2	ounces.
Water....	50	"

Great care should be taken that the solution is not overheated, and that the paper is coated without bubbles. It is then dried in a temperature of 60° Fahr. The paper will take about ten hours to dry, and in this state will keep for years. When required for use it should be sensitized by floating, or immersing, in a bath of:

Bichromate of potash......	1	ounce.
Chloride of sodium.........	½	"
Ferricyanide of potassium.........	100	grains.
Water..............................	30	ounces.

This need not be done in the dark room, as the solution is not sensitive to light.

The paper, after sensitizing, is dried in a temperature of 70°, and in a dark room. When dry, it is exposed under any half tone negative, in the ordinary printing frame. It is preferable to print in sunlight, and, for negatives of medium density, an exposure of three minutes is required, but the exposure will vary according to the density of the negative. The correct time of exposure can best be judged by looking at the print in the frame. When the image appears on the transfer paper of a dark fawn color on a yellow ground, the transfer is sufficiently printed. It is put into a bath of cold water about ten minutes, until the soluble gelatine has taken up its full quantity of water, then taken out, placed on a flat piece of stone, glass, or zinc plate, and the surface dried with blotting paper.

The action of the light has been to render the parts to which it has penetrated through the negative partly insoluble, and, at the same time, granulated. A hard transfer ink is now used, composed of:

White virgin wax.....................	⅛	ounce.
Stearine	⅛	"
Common resin..................	½	"

These are melted together in a crucible over a small gas jet, and to them are added four ounces of chalk printing ink, and the mixture reduced to the consistency of cream with spirits of turpentine. A soft sponge is saturated with this mixture, and rubbed gently over the exposed paper (in this stage the nature of the grain can be best seen). An ordinary letter press roller, charged with a little ink from the inking slab, is then passed over the transfer, causing the ink to adhere firmly to the parts affected by the light, and removing it from the parts unacted upon. It will be found that with practice, rolling slowly and carefully as a letter press printer would his form, the ink will be removed by the roller according to the action that has taken place by light, leaving the shadows fully charged with ink, and the high lights almost clear, the result being a grained transfer in greasy ink. The transfer is next put into a weak bath of tannin and bichromate of potash for a few minutes, and when taken out the surplus solution should be carefully dried off between clean sheets of blotting paper. The transfer is hung up to dry, and, when thoroughly dry, the whole of the still sensitive surface should be exposed to light for about two minutes. A weak solution of oxalic acid should be used for damping the transfer (about 1 in 100), and this should be applied to the back of the transfer with a soft sponge. After it has been damped about four times, it should be carefully put between clean sheets of blotting paper, and the surplus moisture removed. A cold polished stone is then set in the press, and, after everything is ready, the transfer is placed on the stone and pulled through twice. The stone or scraper is then reversed, and the transfer is again twice pulled through. A moderate pressure and a hard backing sheet should be used, care being taken not to increase the pressure after the first pull through. The transfer is taken from the stone without damping, when it will be found that the ink has left the paper clean. Gum up the stone in the usual way, but, if possible, let the transfer remain a few hours before rolling up. Do not wash it out with turpentine, and use middle varnish to thin down the ink.

It should have been mentioned that varying degrees of fineness of grain can be given to the transfer by adding a little more ferricyanide of potassium in the sensitizing solution, and drying the transfer paper at a higher temperature, or by heating the paper a little before exposure, or by adding a little hot water to the cold water bath, after the transfer has been fully exposed. The higher the temperature of the water, the coarser the grain will be. The finer grain is best suited to negatives from nature when a considerable amount of detail has to be shown.

The coarse grain is best for subjects in monochrome, or large negatives from nature, of architecture, etc., where the detail is not so small. Even from the finer grain several hundred copies can be pulled, as many as 1,200 having been pulled from a single transfer.—*Photographic News.*

THE MECHANICAL EQUIVALENT OF HEAT.

By C. J. HANSSEN, C.E., of Kolding, Denmark.

VARIOUS experimenters and theorists have determined the mechanical equivalent of heat, but their figures, although not differing to a very great extent, do not agree perfectly, and thus introduce some uncertainty into technical calculations. The figures generally used are as follows:

Joule.—1 British thermal unit...........	(lb. °F.)	= 772 foot pounds.
" 1 calorie..........	(Kg. °C.)	= 424 m. kg.
Regnault.—1 calorie.......	"	= 435 "
Hirn.—1 calorie	"	= 424·9 "

In the following calculations I will endeavor to find the correct figures, adopting for the purpose a method which I think cannot be disputed. In my calculations I use the following universally accepted data:

1 meter	=	3·2809 feet Eng.
1 sq. m.	=	10·7642 sq. ft. "
1 cub. m.	=	35·317 cub. ft. "
1 kilog.	=	2·2046 lb. "
1 foot	=	0·30479 meter.
1 sq. ft.	=	0·0929 sq. m.
1 cub. ft.	=	0·028315 cub. m.
1 lb.	=	0·45359 kilog.
Atmospheric pressure = 29·922 inches	=	760 mm. mercury.
Specific gravity of mercury at 0° C. (32° F.)	=	13·596.
Atmospheric pressure = 760 mm. × 13·596	=	10·33296 on head of water.
Atmospheric pressure per square meter	=	10,332·960 kilos.
Atmospheric pressure per Eng. square foot	=	2116·278 lb.
Freezing point of water = 0° C. = 273° C. absolute	=	32° F. = 491·4° F. absolute.
Boiling point of water = 100° C. = 373° C. absolute	=	212° F. = 671·4° F. absolute.
Specific heat of air at constant volume	=	0·1686
Specific heat of air at constant pressure	=	0·2377
1 Eng. cub. foot of air at 0° C. = 32° F. = 491·4° F. absolute, and 29·922 inches = 760 mm. pressure weighs............		0·080743 lb. Eng.
1 cubic meter of air at the same temperature and density weighs....		1·29348 kilos.

The volume of air or its pressure is doubled by doubling its absolute temperature.

To heat 1 English cubic foot of air at atmospheric pressure (29·922 inches = 760 mm. of mercury) and 32° F. (0° C.) temperature, weighing 0·080743 lb., 491·4° F. (from 491·4° to 982·8° F. absolute) requires:

At constant volume— Thermal units (lb. °F.).

$$0{\cdot}1686 \times 0{\cdot}080743 \text{ lb.} \times 491{\cdot}4° \text{ F.} = 6{\cdot}689561$$

At constant pressure—

$$0{\cdot}2377 \times 0{\cdot}080743 \text{ lb.} \times 491{\cdot}4° \text{ F.} = 9{\cdot}431249$$

Difference . . . . . 2·741688

This has served to expand the original volume of 1 cubic foot to 2 cubic feet, and enabled it to perform work, and, if acting on a piston of 1 square foot area, the expanding air would move this through 1 foot stroke, and perform work equal to 1 ft. × 1 sq. ft. × 2116·2783 lb. = 2116·2783 foot pounds. As this work would be the result of spending 2·741688 thermal units, it follows that the mechanical equivalent of 1 thermal unit (lb. °F.) is equal to—

$$\frac{2116{\cdot}2783 \text{ pounds}}{2{\cdot}741688 \text{ ther. units}} = 771{\cdot}89 \text{ foot pounds.}$$

To heat 1 English cubic foot of air at atmospheric pressure (29·922 inches = 760 mm. of mercury) and 0° C. (32° F.) temperature, weighing 0·080743 lb., 273° C. (from 273° to 546° C. absolute) requires:

At constant volume— Heat units (lbs. °C.).

$$0{\cdot}1686 \times 0{\cdot}080743 \text{ lb.} \times 273° \text{ C.} = 3{\cdot}7164226$$

At constant pressure—

$$0{\cdot}2377 \times 0{\cdot}080743 \text{ lb.} \times 273° \text{ C.} = 5{\cdot}2395828$$

Difference . . . . 1·5231602

This has served to expand the original volume of 1 cubic foot to 2 cubic feet, and, if acting upon a piston of 1 square foot area, it would move this through 1 foot stroke, and perform work equal to 1 ft. × 1 sq. ft. × 2116·2783 lb. = 2116·2783 foot pounds. As this work would be the result of spending 1·5231602 units of heat (lb. °C.), it follows that the mechanical equivalent of 1 unit of heat (lb. °C.) is equal to—

$$\frac{2116{\cdot}2713 \text{ lb.}}{1{\cdot}5231602 \text{ units}} = 1389{\cdot}40 \text{ foot pounds.}$$

To heat one cubic meter of air at atmospheric pressure (760 mm. = 22·922 inches of mercury) and 0° C. temperature, weighing 1·29348 kilos., 273° C. (from 273° to 546° C. absolute), requires:

At constant volume— Calories (kg. °C.).

$$0{\cdot}1686 \times 1{\cdot}29348 \text{ kilos.} \times 273° \text{ C.} = 59{\cdot}53603874$$

At constant pressure—

$$0{\cdot}2377 \times 1{\cdot}29348 \text{ kilos.} \times 273° \text{ C.} = 83{\cdot}93663350$$

Difference . . . 24·40059476

This has served to expand the original volume of 1 cubic meter to 2 cubic meters, and enabled it to do work, and, if the air were acting upon a piston of 1 square meter area, it would move it through 1 meter stroke, and produce work equal to 1 m. × 1 sq. m. × 10,332·96 kilos., = 10,332·96 m. kg. As this work would be the result of spending 24·40059476 calories, it follows that the mechanical equivalent of 1 calorie (kg. °C.) is equal to—

$$\frac{10332{\cdot}96 \text{ m. kg.}}{24{\cdot}40059476 \text{ calories}} =$$

423·478 m. kg. (= 3062·889 foot pounds.)

In calculating for steam engines or for other heat engines, the following figures, which are based upon the above, will be found to be very useful:

$$1 \text{ H. P.*} = \frac{33000 \times 60}{771{\cdot}89 \text{ ft. lb.}} =$$

2565 ther. units (lb. °F.) per hour.

$$1 \text{ H. P.*} = \frac{33000 \times 60}{1389{\cdot}40 \text{ ft. lb.}} =$$

1425 units of heat (lb. °C.) per hour.

$$1 \text{ H. P.*} = \frac{33000 \times 60}{3063{\cdot}047 \text{ ft. lb.}} =$$

646·415 calories (kg. °C.) per hour.

1 metric h. p. (75 m. kg. per second) =

$$\frac{75 \times 60 \times 60}{423{\cdot}478 \text{ m.kg.}} = 637{\cdot}7 \text{ calories.}$$

—*Jour. of Gas Lighting.*

* Eng. h. p. = 33,000 ft. lb. per minute.

THE DIRECT OPTICAL PROJECTION OF ELECTRO-DYNAMIC LINES OF FORCE AND OTHER ELECTRO-DYNAMIC PHENOMENA.*

By Prof. J. W. MOORE.

A CURRENT of electricity may be regarded as a magnet or a magnet may be regarded as a collection of currents. The former, Faraday's, method is more fruitful of results than the latter, which is Ampere's. Although the effect of the current is both in the wire and medium, an early recognition of the "field of force" surrounding a wire, through which a current of electricity is passing, is invaluable to the student and gives something tangible which his mind can easily grasp. The danger of making the subject too materialistic is small compared to the advantage gained in an easy apprehension and retention of the facts of the subject. It is for these reasons that it is better to begin the subject by an exhibition of the field.

The familiar experiment, Figs. 2, 2*a*, of sprinkling iron filings upon a plate—placed over a magnet—first shown by Dr. Gilbert, can easily be projected upon the screen by means of the vertical lantern. The iron filings arrange themselves, when the plate is briskly tapped, along certain definite lines, which Faraday called "lines of force." These lines represent the direction of the resultant magnetic force. The following experiments are an application of the same principle to the projection of electro-dynamic lines of force. This method is far more striking than the simple exhibition of photographic copies or of the real "spectra" gummed upon glass plates. The apparatus is in permanent form, and may be used afterward in the laboratory for the production of the lines.

The details of the figures come out with rare beauty. With the exercise of ordinary care and a little practice as good spectra can be obtained before an audience as in the laboratory.

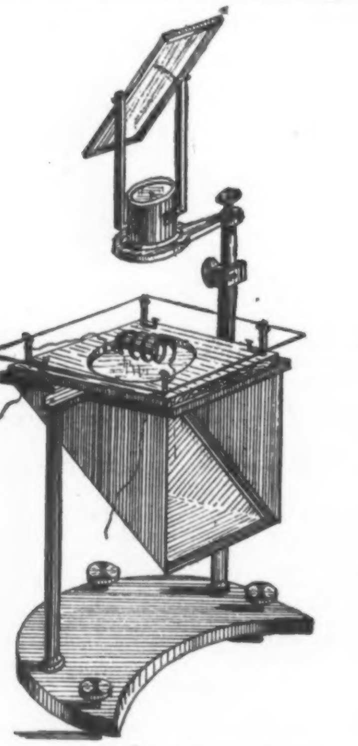


Fig 1a.

A glass millimeter scale may be placed on or under the plate and its enlarged image projected upon the field, or a large rule may be laid upon the screen itself.

A sight of the figures in actual formation converts a lifeless exhibition into an interesting and inspiring study.

The apparatus consists of, Fig. 1: (1) Two bichromate of potash batteries, B_1, B_2, of the dip variety, each having ten one quart cells. The plates are $6 \times 3 \times \frac{3}{8}$ in. The batteries are coupled "in series." After the curves are well formed the zincs are removed from the solution or the circuit broken to prevent any disturbance of the field by electrical action (2) A special plate, P, made of glass, 7 inches square by ⅛ of an inch thick, for the field. Four brass legs, L, 1½ inches long, are attached to the four corners. The wires, W, are attached to the upper parts of these legs temporarily with screws or permanently with solder. (3) A base, B, of baked wood or other insulating material placed upon the stand of the vertical lantern. It remains there during the course of the experiments. At the four corners are four brass clamps, C, with thumb screws. These clamps are fastened to the base permanently, and each one has a binding post for connection with the batteries. When a new plate is to be introduced the four legs of the plate are placed between the fingers of the four clamps and good contact made with the binding screws. (4) The lantern may be either of the American or French form: the former is preferable. It is placed at such a distance from the screen that when the field is well defined the diameter of the converging pencil of light at the glass plate upon which the "spectrum" is formed is three inches and a half across. The field upon the screen is then more than thirteen feet in diameter. The effect of the current is often shown over the whole of the field In no case is the spectrum less than ten feet in diameter.

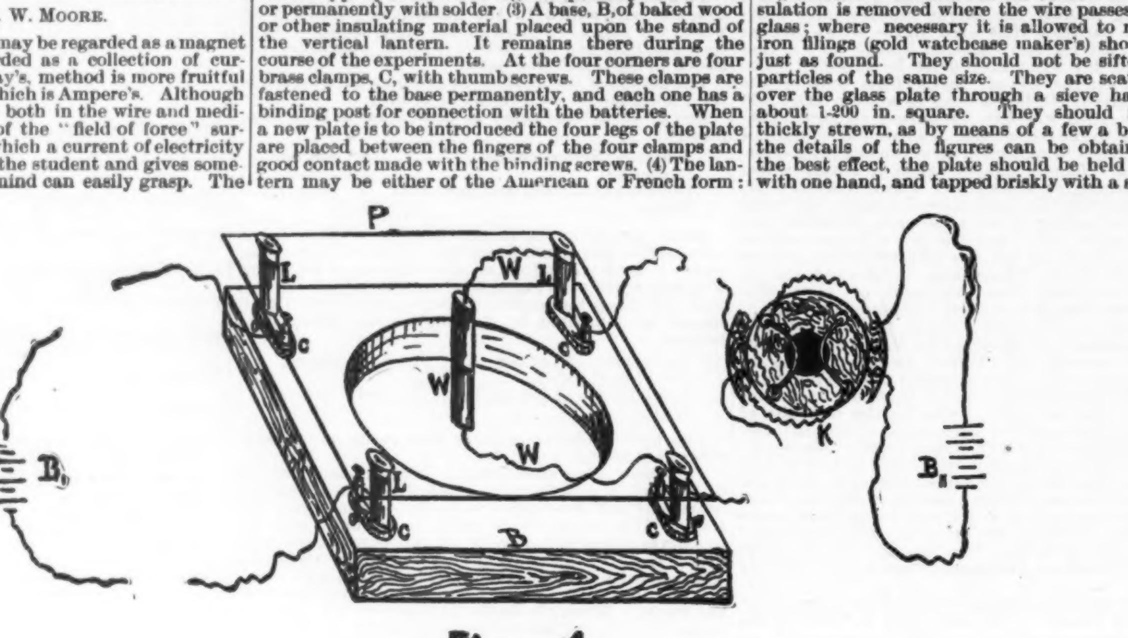


Fig. 1.

Fig. 1*a* represents the stand of the vertical lantern with a plate in position. The wire, W, used for the plate is No. 16 copper, B. W. G. (unless otherwise stated), covered with braided cotton and linen. The insulation is removed where the wire passes through the glass; where necessary it is allowed to remain. The iron filings (gold watchcase maker's) should be taken just as found. They should not be sifted to obtain particles of the same size. They are scattered evenly over the glass plate through a sieve having meshes about 1-200 in. square. They should not be very thickly strewn, as by means of a few a better view of the details of the figures can be obtained. To get the best effect, the plate should be held down firmly with one hand, and tapped briskly with a small wooden mallet. The blow should be vertical and upon various parts of the plate.

The connections are very simple. The two poles of one battery are connected with one set of binding posts and the poles of the other battery with the other.

In the circuit of the second battery a commutator, K, is placed so that the direction of the current may be changed without touching the apparatus on the lantern stand.

Fig. 2 represents the appearance of the field surrounding a bar magnet.

Fig. 2*a* represents the field when the magnet is placed perpendicular to the plate.

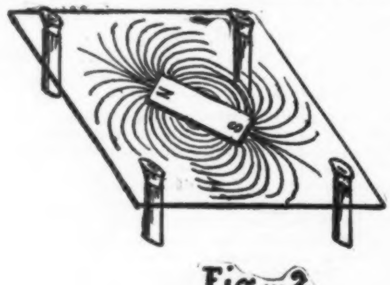


Fig. 2.

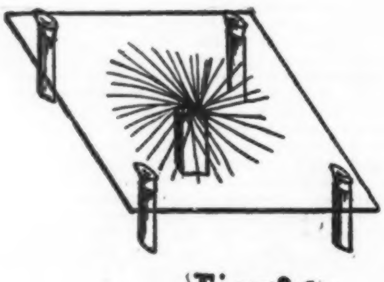


Fig. 2a.

I. STRAIGHT CONDUCTORS.

In the plate represented by Fig. 3, a vertical copper rod 4¼ in. long and $\frac{3}{16}$ in. thick is cut in two pieces. Two of the ends are screwed together with the glass plate between them. At the upper and lower ends of the rod are two binding screws, by means of which connection is made with two legs of the plate. These ends may be soldered permanently to the legs and to the rod. When the filings are strewn over the plate and the current passed, they arrange themselves as represented in the diagram. It follows, therefore, that *a straight wire through which a current of electricity is passing is surrounded by a field of force*; also that *the lines of force are concentric circles in planes at right angles to the length of the conductor and having the conductor as a common center.*

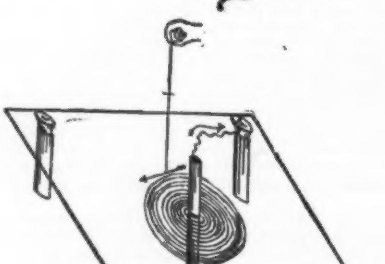


Fig. 3.

If the wire is stretched across the plate (Fig. 3*a*), the circles become straight lines at right angles to the conductor.

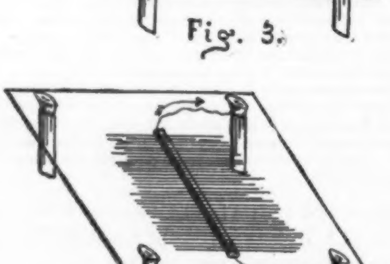


Fig. 3a.

The distances between two adjacent lines of force will be proportional to the squares of their distances from the center. The equipotential surfaces will be radial, with the wire as a common axis, at equal angles from each other.

THE EFFECT PRODUCED BY ONE FIELD UPON ANOTHER.

A. To illustrate the effect produced by a *bar magnet upon the field of a straight conductor*, in Figs. 4 and 4*a*, a small bar magnet is cemented to the plate nearly tangent to the "lines of force;" in the first case almost in a condition of stable equilibrium, in the second the equilibrium is unstable.

Now, Faraday imagined that the lines of force shortened in the direction of their length, and repelled each other when placed side by side.* If this were so in Fig. 4 the N end of the magnet would be urged one way, and the S end the other, and the magnet would finally

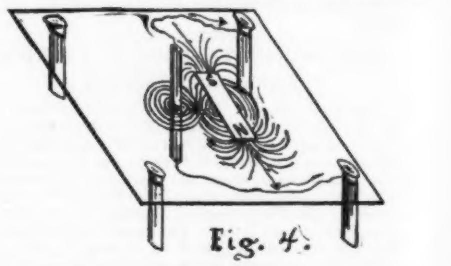


Fig. 4.

Fig. 4a.

* An expansion of two papers read before the A. A. A. S. at the Ann Arbor meeting.

* Experimental Researches, §§ 3266-7-8.

place itself tangent to the lines of force, or, if the magnet were fixed and the current movable, the current would tend to place itself so that its lines would be tangent to the axis of the magnet.

Fig. 4*a* shows that if the magnetic axis is not already parallel to the lines of force, it will become so by the contraction of the magnetic curves.

To show the fact itself, project upon the screen the field of force due to the rectilinear vertical current. After the filings have arranged themselves in the circular form, carry a suspended magnetic needle over the field. The needle will tend to place itself tangent to the circles with the north end in a position determined by the direction of the current (see Fig. 3). *If the plate is imagined to be held over one's head, and the current to pass vertically upward, the N end of the needle will be impelled in a clockwise direction, if one looks in the direction of the current.* If the direction of the current is changed by the commutator, the lines will remain circles, but the N end of the needle will be urged in the opposite direction. If the current is regarded as movable, a man swimming in the current and *looking along the lines of force of the pole of the magnet* will be deflected, with the conductor, toward his left. This method of remembering the facts is sometimes preferable to the other.

The positive direction of a line of force is the direction in which a N pole, if isolated, would be urged along the line of force.

When poles of the same name are urged in the same direction along lines, Faraday called them "like lines," when in opposite directions "unlike lines." If the suspended magnet is held over the horizontal wire, Fig. 3*a*, for reasons similar to those given above it will place itself at right angles to the length. But these are Oersted's experiments. A few moments' reflection will show that the above statement is precisely the same as the usual one, "if you imagine yourself swimming 'with the stream,' in the current, with your face toward the magnet, the N pole will be deflected toward your left."

If the magnet is placed with its length perpendicular to the straight wire, as in Figs. 4*b*, 4*c*, the peculiar form

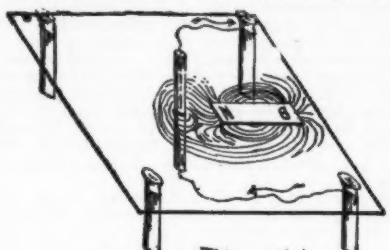


Fig. 4 b.

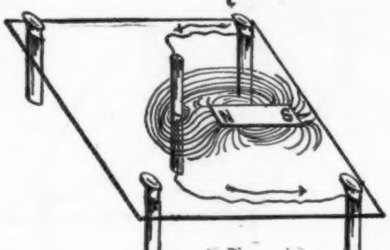


Fig. 4 c.

of the lines shows that the magnet, if free, would place itself as in the previous cases. In one figure the current passes upward, in the other downward. It is noticed that the spiral changes its direction if the current is changed in direction.

Again, if the magnet be placed parallel to the vertical straight wire (Figs. 4*d* and 4*e*), the field will show, on an

Fig. 4 d.

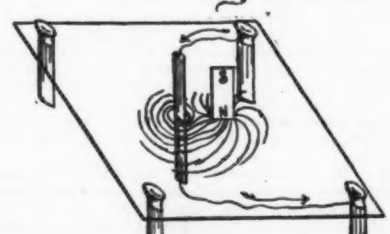


Fig. 4 e.

application of Faraday's criterion, that the magnet will be rotated, in one direction if the current passes upward, and in the opposite if either current or magnet is reversed.

The fact of rotation of a *current* may be shown by means of the following apparatus (Fig. 5).

A vertical pillar, P, upon which an electro-magnet, E, slides, is fastened to the center of a glass plate, G. At the top of the pillar is a small depression, D, in which a drop of mercury is placed. In this depression is a pivot which supports a strip of copper, C, bent six times at right angles, so that its extremities dip in the mercury of a circular wooden trough, T, and at the same time it presents the long arms to the influence of the magnet. When the current is passed, the copper

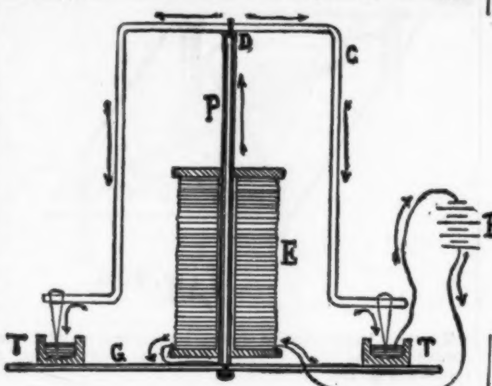


Fig. 5.

strip rotates about the magnet. The connections are obvious in the figure. Fig. 4 *f* represents the field in one aspect corresponding to this apparatus.

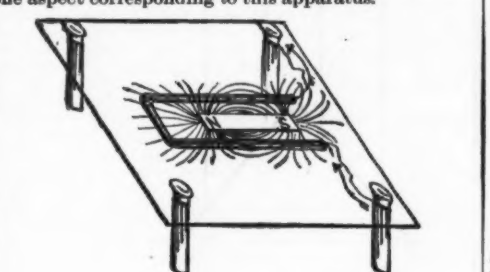


Fig. 4 f.

The same thing may be shown by using a small Barlow's wheel.

On the under side of a glass plate a small bar magnet, S N, is cemented; on top, another, N S, of the same

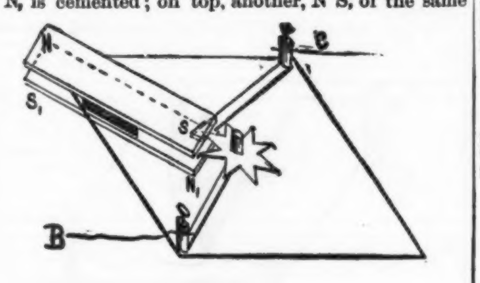


Fig. 6.

size with poles reversed. The upper one should be raised ⅜ of an inch by means of a small block. Pivoted upon one end of a copper strip is a small star-shaped copper wheel, with the points turned down. The other end of the strip is connected with a binding post, B. A small mercury cup is placed on another copper strip running from the second binding post, C, toward the center of the plate, so that the points of the star lightly touch the mercury. The connections are so arranged that the current passes from the battery to the center of the star, thence along a ray to the mercury cup back to the battery. When the circuit is closed, the wheel deliberately rotates. The magnets are two inches long; the wheel about 1½ inches in diameter.

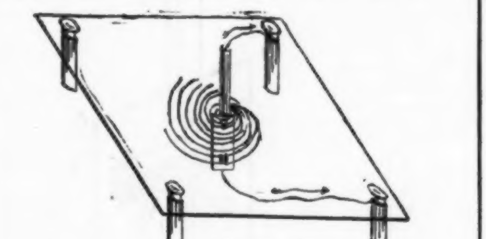


Fig. 4 g

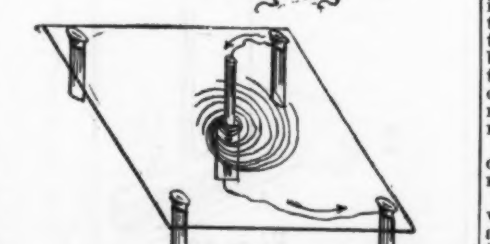


Fig. 4 h.

If the current is made to pass through the axis of the magnet [which may be done by drilling a hole in the end of the magnet and screwing a small copper rod, with the glass between the two ends, Figs. 4 *g*, 4 *h*], a very striking figure presents itself. The same is shown in Fig. 4 *i*, with the compound current laid flat on the plate. Rotation will evidently result if either the magnet or wire is free.

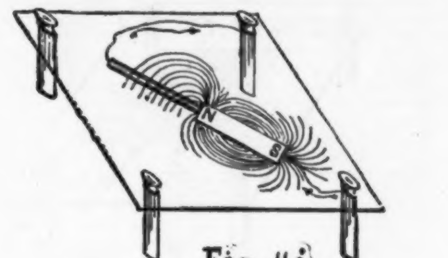


Fig. 4 i.

The actual rotation of the *magnet* may be realized by using the following simple apparatus.

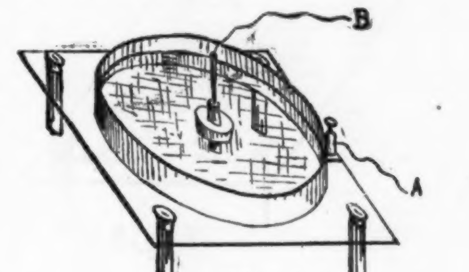


Fig. 7.

A small bar magnet is placed in a perforated cork, and floated upon a dilute solution of sulphuric acid in a copper vessel 2½ inches deep. The bottom of the vessel is glass. Rotation will take place when a current passes through the magnet and water to the copper rim of the vessel back to the battery. A little depression in the upper end of the magnet contains a drop of mercury, and serves to close the circuit by introducing one pole of the battery—the other pole being connected with A. Considerable difficulty may be encountered from the decomposition of the water, but by properly proportioning the current, rotation may be shown. This is Faraday's apparatus, without the mercury to float the magnet.

B. Effects of currents on currents.

a. PARALLEL CURRENTS.

Having thus shown that the wire is magnetic, replace the bar magnet by a vertical wire, and examine the effect produced by the mutual action of the two fields upon each other.

Two parallel vertical rods (Figs. 8, 8 *a*) are introduced

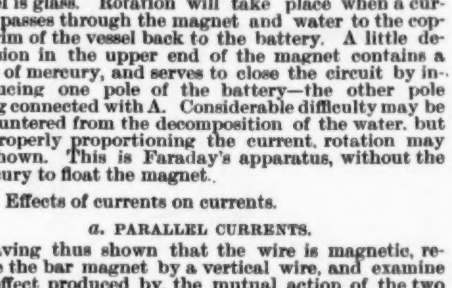


Fig. 8.

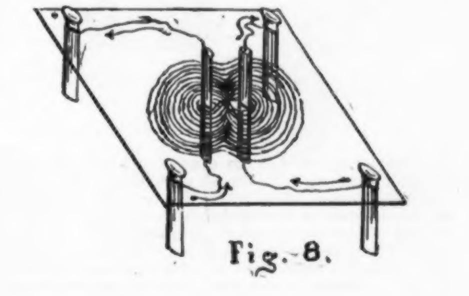


Fig. 8a.

into the glass plate, the extremities of one being joined to one pair of legs of the plate and the extremities of the other to the other legs. In this experiment two batteries are used, in the circuit of one of which the current passes in the one direction, and in the other in an opposite direction. The reversal of the current in one circuit is effected by the commutator already mentioned.

In Fig. 8, the curves are like figures of eight or lemniscates; in 8 *a* the curves are so different that there is no danger of confusion.

If Faraday's idea be applied to the lines in Fig. 8, it will appear that the conductors will attract each other, and in Fig. 8 *a* that they will repel each other; but this is Ampere's first law—that *parallel currents in the same direction attract, and in opposite directions repel each other.*

In Figs. 8 *b* and 8 *c*, the two wires are laid side by side, about one half an inch apart. An application of another of Faraday's notions will give the direction of motion for he held that *like lines, when end on, attract, and unlike lines repel*, when similarly placed. Now,

when the two currents flow in the same direction, a N pole will be urged, by each one, in the same direction; hence the lines are alike and attract; when in opposite

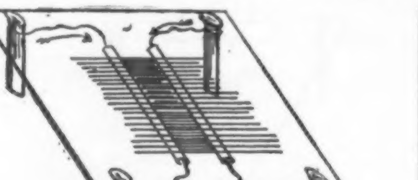


Fig. 8b

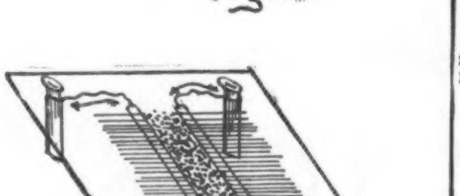


Fig. 8c

directions, repulsion will follow, because they are unlike.

The actual attraction and repulsion may be projected by the use of the following apparatus.

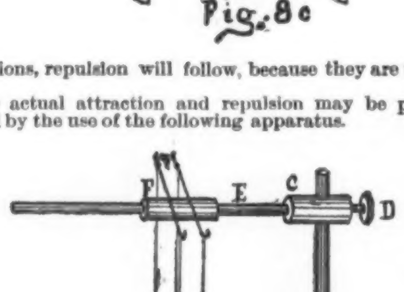


Fig. 9.

A brass ring, A, 6 in. in diameter, is placed upon the vertical lantern. A metal upright, B, 6 in. long, is screwed to the ring. On the upright, a socket, C, slides, having a horizontal arm, E, 5 in. long, upon which various brass collars, F, can be slid. A set screw, D, serves to fasten the horizontal bar in any position. On opposite extremities of a diameter at right angles to the horizontal rod are placed upon the ring two vulcanite troughs, G and H; one having a vertical transverse partition of vulcanite, I. The troughs are filled with mercury. The battery connections are made through these troughs, which are $2\frac{3}{4}$ in. $\times \frac{1}{2}$ in. and of convenient depth.

One of the collars, F, has placed on it transversely two horizontal wires, from which may be suspended, by means of unspun silk, two light copper wires, five and one half inches long. The ends of these wires are bent at right angles, and dip lightly into the mercury, which fills both troughs completely. One trough is connected with the positive, the other with the negative pole of the battery. The current divides itself between the wires, and attraction takes place. To show the second part of the law, the mercury may be wiped from the top of the vulcanite partition. The current will now pass in opposite directions through the two movable wires, if the two poles are placed on opposite sides of the partition.

b. ANGULAR CURRENTS.

Figs. 10, 10*a* show sufficiently the effect produced by

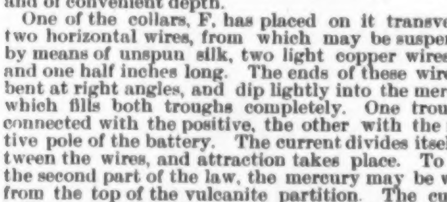


Fig. 10.

crossing the wires in the same plane. An application of Faraday's principle shows that this is an illustration of Ampere's law of angular currents: *if two currents both flow toward or from an angle, attraction will result; if one flows toward and the other from, repulsion.*

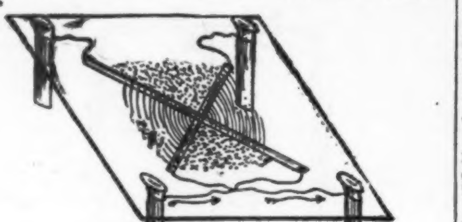


Fig. 10a.

The fact itself may be shown by placing on the horizontal bar of Fig. 9 the apparatus represented as follows (Fig. 11).

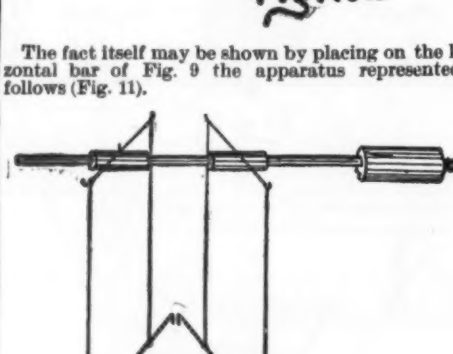


Fig. 11.

The support of one of the wires is pivoted upon the top of the collar; hence it may be inclined in direction to the other. By using the mercury troughs, as in the previous experiment (Fig. 9), the law may be demonstrated.

If one wire (Fig. 10 *b*) is horizontal and the other

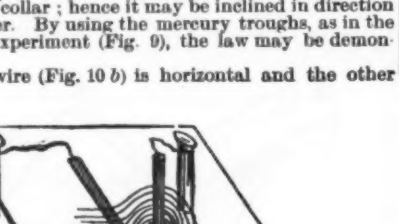


Fig. 10b.

vertical, the lines will present an appearance of attraction or repulsion, according to the direction of the current. The construction of the plate is sufficiently evident. The distance between the vertical and horizontal wire is half an inch.

The apparatus represented in Fig. 12, used with a horizontal lantern, will prove the truth of the law, some-

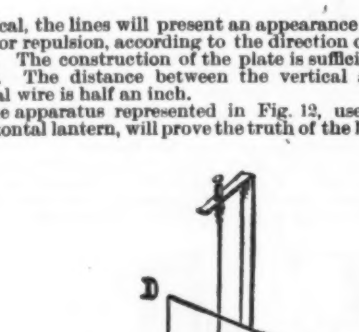


Fig. 12.

times stated—"if both currents flow toward or from the feet of a common perpendicular, there will be attraction, but repulsion if," etc. This is obviously only another statement of Ampere's second law.

On a suspended glass plate, A B C D, two vulcanite troughs, V_1, V_2, are cemented, at right angles to the length of the plate. A copper strip, K, hung from a support by a *long* piece of unspun silk, has one end touching the mercury in the upper trough, the other end in the lower. When a part of the conductor is brought under the lower trough, the vertical wire leaps to the right or left, according to the direction of the current.

In Fig. 10 *c* half of one of the cross wires of Fig. 10 is taken.

The field shows that the radial current would rotate if free, and also the direction of rotation. At the extremity of the short wire is a little mercurial contact. The connections are obvious.

The actual rotation may be exhibited by the apparatus shown in Fig. 13.

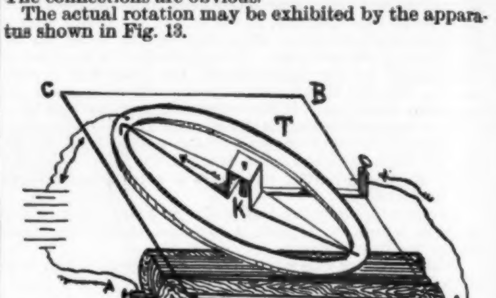


Fig. 13.

A wooden circular trough, T, half an inch wide, is screwed or cemented upon a glass plate, A B C: in its center, K, is an upright metal pillar, with a little depression containing a drop of mercury: a light copper strip is balanced on this pillar—*one* end of the strip just touching the surface of the mercury in the circular trough. A small coil of insulated wire is placed under the glass plate. The current passes from the battery through the coil to the central pillar, through the movable strip, to the trough, thence to the battery. When the circuit is closed, the strip of copper rotates rapidly.

These facts may all be summed up in the rule that for *stable equilibrium the two currents will so place themselves that their lines of force shall all have the same direction;* which is the same as saying *that the*

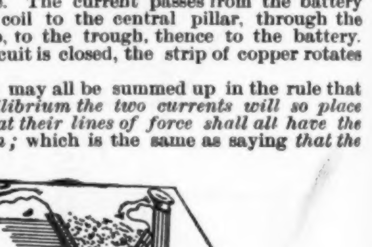


Fig. 10c.

currents shall be parallel, and flow in the same direction.

(*To be continued.*)

A VERY VALUABLE LESSON FOR THOSE WHO USE ANÆSTHETICS.*

By Julian J. Chisolm, M.D., Professor of Eye and Ear Diseases in the University of Maryland and Surgeon in Charge of the Presbyterian Eye and Ear Charity Hospital of Baltimore City.

R. A——, a robust, healthy child, three years of age, was recently brought to me with a cancerous left eye. The attention of the parents was first called to the yellow appearance of the pupil eighteen months before. The gliomatous mass filled the vitreous cavity, distending the pupil, and obliterating the anterior chamber. The eye was injected and painful. The prompt removal of the eyeball was urged as the only means of protecting the child from a painful death. The operation was accepted by the parents, and the enucleation, under chloroform, accomplished after much difficulty, as the sequel will show.

The child was suffering from a bronchial trouble, but that was not deemed an obstacle to the administration of an anæsthetic. The patient was placed on the operating table, his clothing loosened about the neck and chest, and chloroform was inhaled from a towel, folded in conical form, with open top. Deep sleep was soon induced.

When the anæsthesia was complete, the operation for the removal of the diseased eye was commenced. The conjunctiva was divided around the cornea, and the tendon of the external rectus muscle was being sought for, when respiration suddenly ceased. The face assumed a death-like pallor, the pulse disappearing at the same time from the wrist. Immediately the child was suspended by the feet, with body and head hanging down at an inclination of seventy degrees, while an assistant volunteered chest compression for artificial respiration. After a few minutes, signs of a feeble respiratory movement were noticed, a slight throbbing of the neck vessels was detected, and in time the child evinced its return to consciousness by crying.

He was laid on the table, but would not permit the eye to be touched without a twist of the head, evincing great irritability or sensitiveness of the conjunctiva.

* Paper read before the Baltimore Academy of Medicine, December 6, 1887.

As the operation had to be completed, I ordered chloroform to be again administered. Chloroform narcosis was very soon re-established, but before I had time to resume the operation the child again stopped breathing and the pulse disappeared. The body, apparently of a dead child, was once more hung up by the feet, so as to allow blood to gravitate toward the anæmic head and brain, but with no further attempts at artificial respiration. Myself and four assistants watched anxiously the pale face, to catch the first evidence of returning vitality. After some minutes I noticed that the large vessels at the root of the neck showed some fullness; then a slight thrill, and after this the first attempt at a thoracic movement appeared. In ten minutes breathing was sufficiently strong to allow the child to cry again, much to the relief of all of us.

Still, the operation which was so imperatively called for, for the future safety of the child—even the saving of its life from the ravages of cancer—was uncompleted. While the father and mother, both present in the operating room, were pleading for their child, they were made aware, by the restlessness of the patient when the eye was touched, that nothing could be done without the child going again to sleep, so I once more ordered the inhalation of chloroform. For the third time chloroform narcosis was promptly established, and was followed very soon afterward by suspended respiration and the disappearance of the pulse. Death now seemed to be complete. Immediately the child was hung up by the feet. The absolute quiet of the operating room was broken only by the lamentations of the parents. All eyes watched the face of the child. Five minutes seemed an hour, and the ashy lips showed, so far, no response. Soon after this a faint effort at respiration was observed, which became stronger with each return of the thoracic movements, and the pulse was again felt feebly at the wrist. When respiration seemed established, complete insensibility continuing, I had the child laid upon the operating table. As soon as the body assumed the horizontal position, the pulse, not yet strong, disappeared from the wrist, and the respiration ceased, necessitating at once a renewal of the suspension. This curious phenomenon of breathing when suspended, and becoming inanimate when the prone position was too early assumed, was repeated two or three times respectively. For safety—for I was afraid to lay the child down—I was forced to enucleate the eye while the child was suspended with head downward, an awkward position for operating. It was some time, fully a quarter of an hour, after the operation was completed and the eye bandaged, before I could trust the child in the recumbent posture.

One of my assistants was very anxious to have whisky injected, and had filled his hypodermic syringe for that purpose; but I declined its use, trusting to inversion alone for resuscitation. The final successful issue of this case confirmed my faith in this invaluable method, which I had used successfully on former occasions, and hence confided in it for the protection of the patient through the trying ordeal. In all, the child must have been suspended in the inverted position for fully three quarters of an hour. After the last suspension no further trouble ensued. The next day the child was so thoroughly himself that he left the hospital with his parents. He was brought back to the dispensary for inspection, two days afterward, a picture of health.

This case cannot be too carefully studied by surgeons who must continue to use general anæsthetics. It is one of a series occurring to me now and then—I am glad to say, at long intervals—as the consequence of chloroform inhalation.

I am a strong advocate of chloroform, believing it to be the most available remedy of its class. I recognize it as a powerful agent for evil, but at the same time I believe it to be the best of the general anæsthetics. In army life and in civil practice I have had a personal experience of at least ten thousand administrations, and without a death. For thirty years I have had charge of a surgical hospital service, and my daily use of chloroform has been the subject of public professional observation. Sulphuric ether I have seldom used—not one hundred times in my life, and in most of these instances only to exhibit on patients the effects of the various anæsthetics in medical classes at the University of Maryland Hospital clinic. In the last ten years I have not used it once. For painful operations of very short duration I use the bromide of ethyl, and for all others I use chloroform exclusively.

At the Presbyterian Eye and Ear Charity Hospital of Baltimore City, in which institution I am the surgeon in chief, I have used chloroform as often as nine times in one day. The consumption of chloroform in this hospital is computed at hundreds of pounds. A pound of sulphuric ether has never been purchased among the hospital drugs, and it is not administered in the hospital.

My rule of practice has always been to do surgical work with the least possible pain, and to refuse anæsthetics to no surgical patient. In the administration of chloroform certain rules are followed. All clothing must be loose around the neck and chest. With adults, an ounce of whisky is given in advance. In the case of persons under thirty years of age this cardiac stimulant is omitted, unless the patient be feeble. In this hospital practice no precautions as to eating can be observed. The clinic is held at two o'clock every day. Patients are frequently sent from the dispensary to the operating room one hour after they have eaten a hearty meal. If the patient has been admitted into the hospital wards the day before operation, his dinner is withheld.

Chloroform is administered with the patient lying on his back, and as soon as narcosis is induced the pillow is taken from under his head, so that he lies in an absolutely horizontal position. Should snoring occur, indicating some difficulty in pharyngeal breathing, the chin is drawn forcibly upward. This elevation pulls the anterior wall of the pharynx, with the hyoid bone and root of tongue, forward, making for the air a clear and straight passage from the nose into the lungs. By this movement of the chin respiration becomes immediately quiet and easy. The pulling up of the chin is a much more efficient and convenient means of pulling the root of the tongue forward than by pulling out the tongue with a dressing forceps, as is recommended by some surgeons. It is not always easy at this stage of anæsthesia to get into the mouth, as the lower jaw muscles may not be relaxed. A proper tongue forceps is not often at hand, and to tear the tongue substance with sharp toothed and yet slipping instruments, with the soreness and swelling which subsequently follow, is an abominable practice that should be abolished. The patient's chin and your own hands are always present, and it only needs knowledge of the method to apply it, and to secure prompt and speedy relief.

The instrument used for the inhalation is a towel folded in cone form, with the apex of the cone open, so as to permit air to mingle freely with the chloroform vapor. During the administration the face is closely watched by the surgeon. If the ears remain pink, the heart and lungs must work properly; therefore, there is no need for feeling the pulse. Any failure on the part of either of these organs can be seen in the change of the complexion more quickly than it can be felt at the wrist. When the conjunctiva is no longer sensitive, the patient is considered thoroughly anæsthetized, and the administration of chloroform is stopped. In eye work the chloroform administrator must now get out of the way for the surgeon, and therefore the administration of the anæsthetic cannot be injuriously continued. Herein lies one great point of safety with the ophthalmic surgeon.

As I have previously stated, I deny chloroform to no surgical patient. Prior to the discovery of cocaine as a local anæsthetic, I administered chloroform for cataract extractions, enucleations, iridectomies, squints, lid operations, passing of lachrymal probes, or, in fact, any painful operation whatever, and even for the examination of irritable eyes in children. These patients were of all ages from infants to octogenarians, and, of course, represented every condition of disease and health. If restoration to sight could be obtained, operations were performed on the blind, regardless of the diseased conditions of other organs. Some patients were strong and some were very feeble, with lung, heart, and kidney diseases. No pathological lesion in any other part of the body deters me from the use of chloroform should an eye operation be required.

Cataract patients are usually old; most frequently they exhibit decided senile changes. I suppose an average of sixty years of age would represent this class of patients; seventy, seventy-five, to even eighty-five, ninety, and ninety-five, are at times the respective ages; ninety-six is the extreme age at which a successful cataract extraction has been performed under chloroform at the hospital. It is well known that fatty hearts are very frequently found in old subjects in dissecting rooms. My cataract operations now reach fifteen hundred. Of these, many must have had fatty hearts. Prior to the last two years, before cocaine came into use as a local anæsthetic, I gave chloroform in all cataract cases, and therefore must have given it to many patients with fatty hearts.

Very feeble heart pulsation, with irregularity of action, I frequently met with in old patients. With such I always increased the amount of whisky, which I administered in advance of the chloroform inhalation. I consider it much safer practice to put whisky into the stomach, where it is ready for use, if wanted, and where it can do no harm if not needed. I have never had occasion to inject whisky or ether into the rectum or under the skin. The hypodermic syringe forms no part of my chloroforming apparatus.

So far, after thirty years of active surgical life, I can conscientiously say that in no single case have I had cause to regret that I chose chloroform as the anæsthetic. I always give chloroform in the presence of physicians—never alone—and most frequently with the whole surgical staff of the hospital present. Had death from chloroform occurred in my practice, it would have received, necessarily, prompt publicity. That I have never had one, and that I have never refused chloroform to any patient received into the hospital for surgical treatment, is a fact well known.

I repeat, that in my long experience I have never had a death from any anæsthetic, although I have given chloroform to over ten thousand persons of varied sanitary conditions; but I freely acknowledge that I have come very near having a fatal ending more than once. I have had four cases of sudden arrest of respiration, with failure of the heart's action, when death would have inevitably been the final result had not prompt and proper means been taken to resuscitate the patient.

Experience under these severe trials has made me a firm believer in the efficacy of inverted suspension for the restoration of life in patients apparently killed by chloroform. I feel convinced, from my own experience with this invaluable method, that many of the dead from chloroform might have been resuscitated had the surgeon hung up immediately by the feet the inanimate body, instead of wasting time in applying hypodermic injections, cold water splashings, spanking, fanning, electricity, or even attempts at artificial respiration, the remedies which text books on surgery recommend. Do any or all of these things if you will, but hang up the patient first, and that instantly, as soon as the heart and lungs fail. It is the horizontal position that is fatal in chloroform poisoning, and leads to death if the body is kept in it, as all the reports of fatal cases with chloroform show.

With myself it has become a matter of faith, and in suspension alone I now place my confidence. So far it has served me most successfully. Had I not used suspension in the four cases referred to, most of them, probably all of them, would have died. Then my percentage of fatal cases would have corresponded with the average chloroform mortality as reported in some of the text books on surgery, one in twenty-five hundred cases of administration.

By suspended respiration I refer to the complete arrest of all respiratory movements. I do not mean that very feeble state of heart and lung action, accompanied by pallor of face, which frightens so many physicians, and which I know only foreshadows the approaching vomiting. This condition of depression I see with a great many chloroform patients. With me it is only a signal that a basin should be in readiness. I often hear physicians, in giving their experiences, speak of their very narrow escape from a fatal chloroform administration, meaning this stage of depression, which one familiar with chloroform, from its daily administration, would almost call normal.

Many years ago I became very much impressed by certain experiments made by Dr. Nelaton—that well known French surgeon—to show that in chloroform narcosis the respiratory and cardiac centers were weakened by an anæmic condition of the nervous apparatus, the exposed brains of animals bleaching as chloroform vapor was inhaled by them to complete anæsthesia. When this whitened appearance indicated such a condition as to give but little of the needful blood stimulus to the great nerve centers, their functions ceased in a regular order: First in volition, next in voluntary movement, then in general sensation, and finally in the arrest of involuntary or organic movements, including the action of the heart and lungs, and then death promptly ensued. In his experiments he found that when a number of rats had been thoroughly narcotized with chloroform, those which he would immediately hang up by the tail would slowly revive, while those left supine on the table died. If, when animation commenced to show itself in the hung-up animal, the rat was laid down too soon, breathing would again cease, and the rat would die, unless immediately suspended, when the respiratory and cardiac actions would be resumed. It was only after a sufficiently long suspension, giving the brain and heart ample time to have supplied to them, by gravity, a desired amount of blood, that death could be prevented. If the animal was not already dead, suspension alone would restore animation. The knowledge of this fact is daily put into use by vivisectionists in their experiments upon animals under chloroform. The case of the child which I have reported is really in the line of these experiments, and clearly shows the danger of the horizontal position when the heart and lungs fail. The suspending of the human body by the feet to restore animation in chloroform poisoning was Nelaton's great discovery, and is known as his method of restoring patients to life when, under chloroform anæsthesia, respiration has suddenly ceased. The knowledge of, and faith in, this method has served me well on many trying occasions. To it alone I attribute my clean record of over ten thousand cases of general anæsthesia and no death.

Eighteen months since I ordered chloroform to be administered to a patient, eighty years of age, who had his right ear a mass of epithelioma. The pinna was much enlarged, and an offensive, painful ulcer, with ragged outlines, covered nearly the whole surface. The object of the operation was to remove all this fetid, discharging surface, and to close as much of the wound as possible, by quick union. He was of a robust frame, although eighty years of age. In his desire to get rid of the fetid discharge, he submitted without hesitation to the course recommended.

First a full dose of whisky was taken, and then chloroform administered by the resident physician of the hospital, aided by the medical staff. I had left the operating room for a few minutes, to show to a medical visitor some cases of interest in the wards, when the nurse ran to inform me that the man whom I had just left was dead. I hastened with my medical friend to the operating room. I found one of the physicians trying thoracic compression for artificial respiration on an apparently lifeless body, lying flat upon the operating table. I had this immediately stopped, and under instructions the four doctors present, with the nurse and the brother of the patient, held up the lower end of the operating table so as to incline the body and head at an angle of over forty-five degrees, using at the same time all of their restraining force to keep the body from sliding off the table. Nothing else was done. With the inanimate body in this way suspended, we quietly and anxiously awaited results. In a very few minutes we had the satisfaction of seeing slight thoracic movements, then the ashy, livid face lost its death-like hue. When respiration became fully re-established, the table was lowered, and the operation safely completed, no more chloroform being required in this case.

A third case occurred in my hospital experience eight years ago. It was that of a woman, forty-five years of age, who had suffered frightfully from repeated attacks of irido-cyclitis. I had urged an iridectomy as a means of protection from suffering, but on account of timidity she had steadily refused to submit to it. After many sleepless nights of agony, and being worn out by the pain, she finally consented to be operated upon. Loss of sleep and the constant pain had enfeebled her very much. She was given two ounces of whisky before being put on the operating table. Complete anæsthesia under chloroform was soon induced. The eye speculum was being placed in position, when respiration suddenly ceased. No one was feeling the pulse, as I was standing over the face, watching the skin circulation. She looked dead, and we thought her so. Fortunately, there were several physicians present, and immediately she was hung up by the feet. While I watched the effects of suspension on the face, some attempts were made, by rhythmical abdominal pressure, to force air from the lungs and thereby excite a respiratory movement. This, however, was soon desisted from, being inconvenient, and, as I thought, useless. After a few minutes of suspension, respiration was gradually re-established.

The patient, brought back to life, was again laid upon the operating table. She was perfectly relaxed, and I hoped that I could do the iridectomy without any further anæsthesia. The moment I touched the eye a flirt of the head exhibited a degree of irritability, showing plainly that it was impossible to attempt it. As the pulse by this time seemed perfectly re-established, and the stomach contained a good quantity of whisky (there had been no vomiting), I determined again to give her chloroform. A very few whiffs from the charged towel brought on full anæsthesia, and with every promise that the various steps of the operation could now be successfully carried out. The speculum was applied, the eyeball seized, and the cataract knife had transfixed the cornea, when respiration and cardiac action again stopped. The patient now seemed quite dead. The eye instruments were quickly removed, and the patient in an instant was hung up by the feet, with head down. No attempts were made at artificial respiration, nor were any other means used for resuscitation but the inversion, not even throwing open the windows for fresh air. As still as death, we watched the suspended body. After a few minutes, which seemed a very long time to us, a feeble respiratory movement was detected. This slowly developed into full breathing, and brought back the pulse, and with it life to our patient.

She was again laid on the table, utterly limp but breathing freely. When the eye was touched the head made again a sudden movement, showing a degree of conjunctival irritability which rendered the completion of the eye operation impossible. The question

now before me was, whether I should leave the eye with an operation half performed or protect the patient from future suffering by completing what I had started out to do. After consultation I concluded to perfect the operation, and, with an abiding faith in the efficacy of suspension, I ordered chloroform again to be administered. For the third time quiet sleep was quickly induced, and, fortunately, with no further complications or trouble, the operation was successfully and safely completed.

Fanning, fresh air, water splashing, spanking, whisky or ether injections, electricity, artificial respiration—all of them the remedies which physicians rely upon—go for very little, provided the patient be left supine. General experience, unfortunately, has too often shown this. In my experience with chloroform, in cases of suspended animation, all of these means for resuscitation are useless, provided the patient be hung up by the feet without any loss of time, so that blood may flow to the anæmic head and heart, and stimulate the nerve centers before the vital spark goes altogether out. A fire cannot be rekindled by adding fuel if there be no live coals in the grate. Fortunately, suspension of the body needs no preparation nor apparatus for its immediate application. It only needs vigilance on the part of the operator. Should fright make him forget his duty, then precious minutes are lost in trying useless remedies, and these precious minutes can never be recalled.

That all my cases of apparent death from chloroform should have recovered is not merely good luck, nor is it accidental. I know that chloroform, ether and ethyl are powerful agents for good, and also evil. I am sure that I can kill any patient by the abusive or careless administration of either of these invaluable remedial agents, just as I am sure that I can be burned by any kind of heating apparatus, which I am so dependent upon for genial warmth in winter.

The successful administration of an anæsthetic does not consist merely in holding before the nose of the patient a cloth with the narcotizing agent poured upon it. Skill, care, prudence, judgment, and courage in time of need are all necessary to guard the narcotized patient from danger. Too little of the anæsthetic—not enough to protect the important vital centers from the influence of painful reflex actions—is as dangerous as an overdose of the narcotic inhalant. Many of the fatal accidents occur in the hands of timid physicians or dentists who are afraid to administer enough of the anæsthetic to secure the stage of safety, the immunity from reflex disturbances, and who lose their heads in fright when the danger which their want of confidence has induced presents itself.

The lesson which I would impress upon every one who uses chloroform, sulphuric ether, or the bromide of ethyl for general anæsthetic purposes is that prompt suspension, with head down, is the remedy for suspended animation suddenly coming on during acquired narcosis.

No surgeon recognizing the responsibility of his work should ever give an anæsthetic without having some one present. Should there be any sudden and alarming weakening of the heart's actions and of respiration—for they always go together—without a minute's delay hang up the patient. Should the patient be bulky, and should there not be help enough present to elevate the foot of the table or bed, throw the head and body over the side of the bed or table, letting the head hang downward, to receive all the blood that can gravitate into it, holding on to the legs so that the body shall not slide down upon the floor. Should this method of partial suspension not work well, the following more efficient plan should be adopted. When the death of an anæsthetized patient is staring the surgeon in the face, any expedient likely to be useful in restoring the inanimate form to life should be immediately put into practice. Be the patient man or woman, while you stoop, throw their legs over your shoulders, hang on to their feet in front of you, and then lift yourself up. The patient's body, as you get upon your own feet, will hang from your back, with the head down. Now you have time to call for more help if you need it. Never wait for the help to come before you practice suspension, because with the moment's delay your patient may have passed from dying into death, from which there will be no more earthly awakening. When too long delayed—and one minute is a fatal loss of time—suspension is as useless as the other recommended remedies, and can then do no good.

Should the case have been one of needless fright, with only weakening, and not suspension, of the vital functions, no harm has been done. The feeble pulse will always respond promptly to the suspension. It is my constant practice to use suspension for restoring strength to the heart's action after the administration of chloroform, where there is cardiac depression and weak breathing. I use this means of restoring vigor where others use the more objectionable and less efficient hypodermics of whisky or ether, or the inhalations of nitrite of amyl. It is very instructive to observe how promptly the pallor leaves the face, and how strong the pulse will become, as blood gravitates toward the head. Should vomiting occur when the head is hanging down, this suspended position is better for the patient than when lying upon the table, because there is no fear of food particles getting into the larynx. Inversion of the body gives the contents of the stomach free vent.

Such confidence do I feel in the value of suspension with chloroformed subjects, that I am sometimes disposed to believe that the vital centers will not fail with the head hanging down.

Not long ago, in the presence of the medical class of the University of Maryland, I removed by ligature a very large staphyloma from a child one year old. It was the result of purulent ophthalmia of the newly born. The prominence of the opaque cornea was so great that the lids could hardly close over it. The summit of the tumor was being irritated by the constant friction of the lids in winking, and its removal became necessary for the comfort of the child. Under chloroform anæsthesia I transfixed the eyeball at the base of the tumor by two long curved needles, placed at right angles to each other. Behind these, acting as a shoulder, I applied the ligature for the strangulation of the tumor. The medical class could not see from the benches the various steps of the operation upon so small a portion of the body, and from the large number of students present only a few could have crowded around the operating table. After the ligature had been secured, and before the needles were withdrawn, I did not hesitate to hang up the infant by the heels, with head suspended vertically downward, and then walked with it in front of the benches, so that the students could inspect the eye. To the uninitiated this would appear a heartless and dangerous proceeding. My experience and consequent faith in suspension had taught me that this inversion was the safest position for the narcotized child during the tedious inspection.

THE ELECTRICAL ODONTOSCOPE.

WE illustrate herewith an electrical appliance, designed by Mr. Vesey, for the use of dentists in stopping teeth. The illustration (Fig. 1), together with the lettered description, will make the details perfectly clear. Fig. 2 shows the incandescent lamp slipped out of the socket, in which it is held by a bayonet joint; it will be seen that the method of attachment is extremely simple. The filament is joined to two small platinum wires which lie flat against the wooden holder, and when fitted into the socket are pressed against the insulated platinum jaws.

The battery used is a four-cell Victoria Leclanche.—*Electrician.*

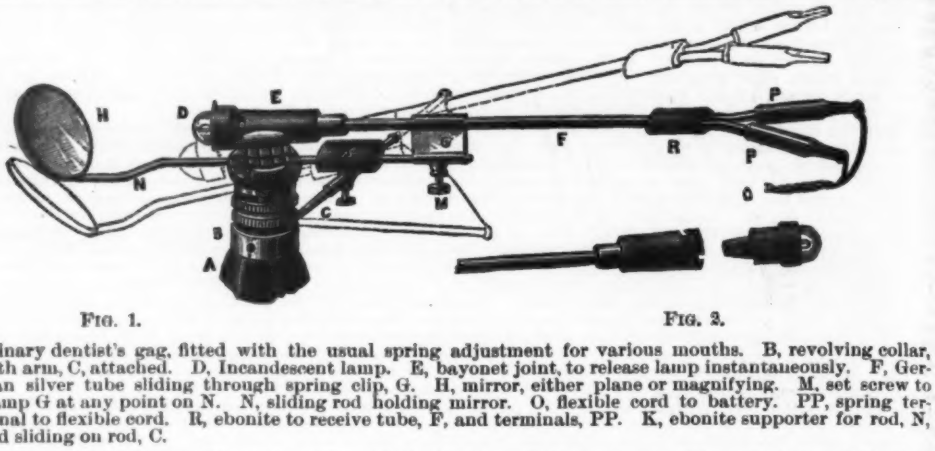


FIG. 1. FIG. 2.

A, ordinary dentist's gag, fitted with the usual spring adjustment for various mouths. B, revolving collar, with arm, C, attached. D, Incandescent lamp. E, bayonet joint, to release lamp instantaneously. F, German silver tube sliding through spring clip, G. H, mirror, either plane or magnifying. M, set screw to clamp G at any point on N. N, sliding rod holding mirror. O, flexible cord to battery. PP, spring terminal to flexible cord. R, ebonite to receive tube, F, and terminals, PP. K, ebonite supporter for rod, N, and sliding on rod, C.

SIMPLE SPHYGMOGRAPHS.

IN order to render the beating of the pulse or heart visible to our eyes, apparatus called sphygmographs are employed. Some of them, like that of Dr. Marey, are self-registering. They are delicate instruments, the prices of which are usually high. For some time past, we have remarked at various exhibitions a small apparatus of an exceedingly moderate price that in most cases gives indications that are sufficiently satisfactory. It consists of a slender brass wire bent double, and formed into a spiral for a portion of its length. The straight part carries a little flag at its extremity. The last spiral is soldered to a little metallic cup (Fig. 1).

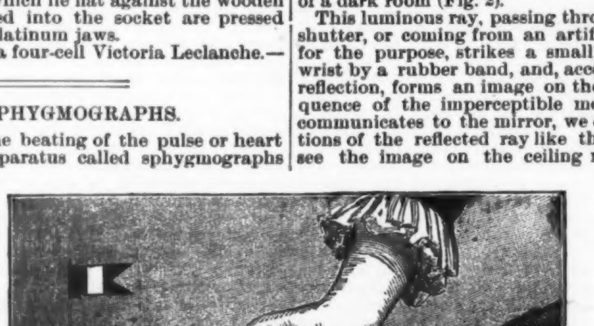


FIG. 1.—A WIRE SPHYGMOGRAPH.

In order to make use of the apparatus, it suffices to press it, as shown in the figure, against the artery whose beatings it is desired to render visible. The rod that carries the flag at once begins to oscillate in a very perceptible manner. The amplitude and frequency of the oscillations necessarily vary with the persons submitted to the experiment.

Were it a question of rendering the pulsations visible to a number of spectators, it would be necessary, in order to amplify them sufficiently, to have a long and light oscillating rod—conditions that it is difficult to reconcile in practice.

Our contributor, Mr. Arthur Good, points out to us a very ingenious solution of the problem, and which consists in substituting for the rod a luminous ray that traces the motions of the pulse on the wall or ceiling of a dark room (Fig. 2).

This luminous ray, passing through an aperture in a shutter, or coming from an artificial source arranged for the purpose, strikes a small mirror fixed to the wrist by a rubber band, and, according to the laws of reflection, forms an image on the ceiling. As a consequence of the imperceptible motions that the pulse communicates to the mirror, we can follow the oscillations of the reflected ray like those of a stiff rod, and see the image on the ceiling moving more or less rapidly, according to the frequency of the pulse of the person submitted to the experiment. A similar means is sometimes employed in hospitals to render pulsations visible, a small paper band being applied to the artery to be studied.

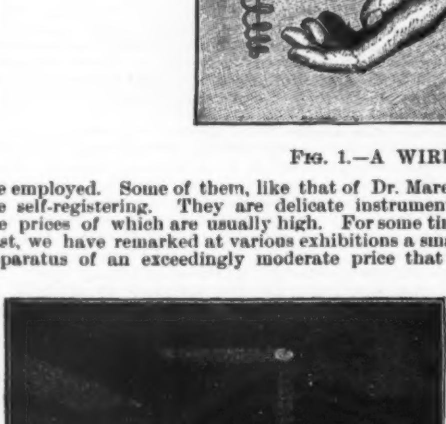


FIG. 2.—A MIRROR SPHYGMOGRAPH.

With the little apparatus shown in Fig. 1, which is wholly of metal, it is easy to render the motions of the artery perceptible to the ear of one or more persons. To this effect, it suffices to solder or otherwise attach a copper wire to the cup that supports the spiral, and then to connect it with one of the poles of a Leclanche pile. The other pole of the pile is connected by a second wire with a small brass rod fixed to the patient's arm by a bracelet in such a way that, at every oscillation, the rod that carries the flag shall abut against the other. On interposing a telephone in the circuit thus formed, a quick stroke is heard at each pulsation.—*La Nature.*

CHINESE DENTISTRY.

I HAD always supposed previous to my arrival in China that the native dentists extracted teeth simply by means of their thumb and forefinger, which, by constant practice, had become phenomenally strong. Even after I had been some years in Pekin I found English residents there who firmly believed this, and I myself did until my curiosity upon the subject became so great that I determined to find out the real truth—a work of some difficulty and time. A friend I had with me during my investigation at first believed that the dentists really did extract teeth with their fingers. The custom and modus operandi of the native dentists of Pekin are as follows: The dental court is held in a large open square near the center of the city. Arranged around this square are rows of booths in which the dentist operates upon the unruly molar. For weeks and weeks we haunted this place, but the dentists were always sharp enough to prevent us making any investigation into their methods. After considerable time had been spent in this unsatisfactory kind of work, we

found an old practitioner who, after considerable persuasion and the promise of good payment, consented to let us both into the secret of Chinese dentistry. Even when we met by appointment, he demurred, not wanting to let the foreign devils know too much. But a little gold soon overcame all objections, and under a promise of the strictest secrecy during our stay in the country the old dentist told us the following:

"No Chinaman ever extracted a tooth with his fingers. He could not do it and knows too much to try. We never extract a tooth unless it is very loose, and even then we use this," and he showed a small iron implement about three inches long and one-half an inch wide, with a V-shaped cut in one end. "With this concealed in our hand we push and pry the tooth, meantime pretending to rub a powder on it to loosen it. When the tooth has been sufficiently worked, a quick motion of the hand and it is out. No one ever sees this instrument, and we encourage the belief that the fingers alone are used in extracting the tooth. When a person comes to us with the toothache, and the tooth is too firmly set for us to get it out, we tell him that some devil in the shape of a worm has got into his tooth and that to take the tooth out will be dangerous, but we will take the annoying worm out and so give relief. This is done, and when the worm is out the man goes away happy."

This was all that the old man would tell us then. After a number of visits to the dental court I was fortunate enough to be present when a woman came in to be treated for toothache. I carefully noted each motion of the dentist, and judge of my surprise when I saw him apparently take a living worm about as large as a grain of rice out of the tooth. A visit to my first informant, an old man, elicited the following: "You are getting bad devils, just as I said you would if you knew too much, but a little more wickedness cannot hurt you, as you are bad devils any way.

"The worms that you thought were taken out of the woman's tooth were not worms at all. In the first place, no dentist has more than one or two real live worms, and as these cannot live long except in a damp place, they are kept in a jar of water, so that in case any one is inclined to doubt we do not actually take them out of the teeth, they can be shown as proof. What we really do is to take an instrument like this [and he showed us a little double-headed steel instrument, with a little spoon-shaped bowl at each end]. Into one end of this instrument we place a piece of pith so made as to exactly resemble a worm. This end we hold concealed in our hand. With the other end we push and scrape around the aching tooth, meanwhile sprinkling a little powder in the mouth and in the tooth. After a few moments we quickly turn the instrument around, bringing the end having the pith worm concealed in it into the patient's mouth, and there we have the worm."

From other sources I learned that false teeth are known to some extent, but they are usually made of wood or metal and fastened into place by means of little clamps fixed around the natural teeth.—*New York Telegraph.*

GRAVITY.

PHYSICAL SOCIETY.

BERLIN, Feb. 3.—Prof. Von Helmholtz, president, in the chair. Prof Paul du Bois Reymond spoke on the difficulty of forming any conception of force acting across an intervening space. From among the various instances of such forces the speaker selected gravity for a thorough discussion. He explained the six properties characteristic of this force, pointing out that only two of them—viz., the proportionality to the mass and the law of inverse squares of the distances—can be proved experimentally, while some of its other properties, as, for instance, the independence of gravity from the condition of motion of the mass, are much doubted by many observers. Prof. Du Bois Reymond then discussed the ever-recurring endeavors in past times to arrive at some mechanical construction for gravity—endeavors which were in all cases unsatisfactory, since they were always dependent either on the fundamental properties of matter, which are themselves incomprehensible, or upon physical phenomena whose basis was still undetermined. Just as in the case of many problems the experiments for whose solution have been repeated until their inaccuracy was clearly proved, so also in the case of gravity has a mechanical conception been repeatedly sought for: hence it becomes necessary to show that gravity is beyond our comprehension, and the speaker proceeded to do this by showing that Lesage's theory of the impact action of the atoms of ether, which has been so long and persistently believed, while it explains the law of inverse squares, does not explain the proportionality to the mass, and in certain special cases leads to perfectly impossible results. Gravity is therefore incomprehensible, and Newton's view that it is something inherently present in all matter is correct, since it is by means of this force alone that matter is made evident to us; indeed, as far as the matter itself is concerned, it may be entirely left out of account. Prof. Helmholtz then explained how he is in the habit of treating the subject of gravity in his lectures. He represents it as being that law of nature, established by experience, that every body when in the neighborhood of another body is subject to an acceleration which is proportional to its mass, and diminishes in the ratio of the inverse square of the distance between them. Such a law of nature as this, established as it is on the basis of experience, is on the whole not unsatisfactory. The same speaker then briefly communicated the results of two researches which he had brought before the Academy of Sciences on the previous day. Of these one is due to Prof. Kundt, and has reference to the refractive power of metals. He has succeeded in constructing transparent prisms of metals, and thus determining their refractive index. The other, due to Prof. Hertz, has for its subject the rate of propagation of electro-dynamic action. By an extremely ingenious method, which the speaker explained, and which has been used by Prof. Hertz, in many of his previous researches, for the measurement of electrical vibrations, he has succeeded in proving that electricity is propagated along a metallic wire at the rate of 200,000 kilometers per second, and that electro-dynamic action passes through dielectrics with the velocity of light. These experiments thus provide the experimental confirmation of the Faraday-Maxwell theory of electro-dynamic action.

THE MYROBALAN OR CHERRY PLUM.

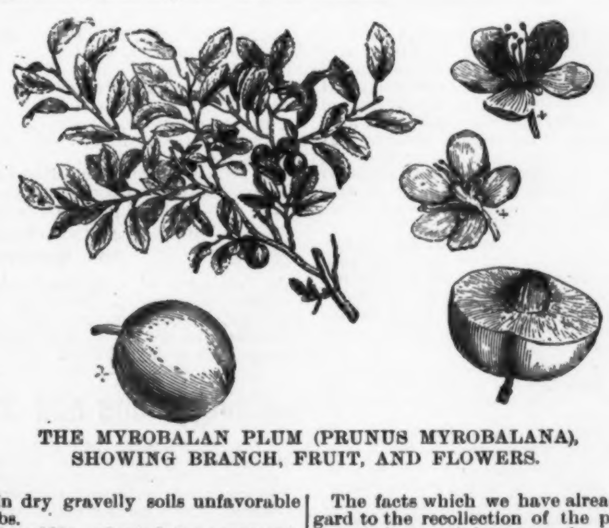
(PRUNUS CERASIFERA.)

OF late years the cherry plum has become well known among planters, not so much as an ornamental tree as for its use as a hedge plant and for covert planting. A few years ago it was a good deal written about. Some even said it made the finest of all hedges, the result being that some nurserymen began to grow it on a large scale for hedges and coverts. Though it will perhaps never surpass the hawthorn or quick as a hedge plant, it is unquestionably well adapted for this purpose, and if planted properly and the soil suits it, a dense, impenetrable growth results in a few seasons. It grows freely in the poorest of soils, which is a great recommendation to it, and if the young plants are managed properly by cutting them hard in when first planted and subsequently looking well to pruning, a hedge that

THE MYROBALAN PLUM (PRUNUS MYROBALANA).

would prevent a hare or rabbit from going through it will be formed in about three years. It must be planted in the same way as quick, viz., in a double row with the plants about a foot apart and alternating in the rows. In hungry soils some good rotten manure should be dug in deeply. It is a good plan to cut the plants down almost to the ground after having been placed in position, and if well rooted they will the first year send up strong shoots, which if pruned back the following winter will, during the second season, make bushy specimens. I do not go so far as to say that it makes a more ornamental hedge than quick, but the leaves are greener and altogether different, and this is very desirable when hedges form conspicuous objects in the landscape. One of the best cherry plum hedges I have seen is in Mr. Wilson's garden at Wisley. It was planted about eight years ago. It is now as tall as a man, and nobody would attempt to break through it. Mr. Wilson has made his hedge highly ornamental, inasmuch as he has at intervals of about 10 feet or 12 feet allowed strong single stems to rise above the hedge, and upon these he has grafted various sorts of plums, and these spreading standards rising out of the hedge have a fine effect, and are moreover useful.

As a covert plant it has been planted largely on some estates, and I was told not long ago by a forester that it promises to turn out a most valuable covert, as it is dense and spreading in growth, and yet not too dense for winged game. As the plants can be bought by the thousand cheaply, there is no reason why it should not



THE MYROBALAN PLUM (PRUNUS MYROBALANA), SHOWING BRANCH, FRUIT, AND FLOWERS.

be tried, especially in dry gravelly soils unfavorable for other covert shrubs.

The cherry plum is seldom planted for ornament, though it possesses considerable merit on account of its being one of the earliest of all trees to flower in spring. It bears a profusion of small white flowers, which are remarkably beautiful if they escape the late frosts. It is but a medium sized tree even under the most favorable conditions of growth, and like the common plum, makes a compact, spreading head. It does not fruit freely in this country, though in some seasons when its blossoms have escaped the frosts, one may see an old tree with a scanty crop of its cherry-like fruits of the size shown in the illustration. They are of a dull reddish color and astringent. The new Prunus pissardi, now becoming so popular in gardens both large and small, is nothing more than a purple leaved variety of the cherry plum; but as it is so distinct that no one would mistake the one for the other, it is convenient to keep to the name Prunus pissardi, or purple leaved cherry plum. As this is a beautiful shrub when forced into bloom early, there is no reason why the cherry plum itself should not be employed for a similar purpose. The myrobalan is used also as a stock for the edible sorts of plums.—*The Garden.*

DURATION OF MEMORY IN WASPS.

IN studying the psychology of insects, it is noteworthy that we have very little satisfactory evidence with regard to duration of memory. Belt's observation on leaf-cutting ants, which tends to show recollection of a locality for one year, is by no means conclusive, as the facts are as well if not better explained by supposing that the ants accidentally stumbled upon the old vacant nest. Also with bees, the observations of both Stickney and Huber are inconclusive. Stickney's evidence on the subject, as given by Romanes,* is as follows:

"Stickney relates a case in which some bees took possession of a hollow place beneath a roof, and having been then removed into a hive, continued for several years to return and occupy the same hole with their successive swarms."

It would be hardly safe to conclude that bees have extended powers of memory from so indefinite an account as this.

Again we quote from Romanes: †

"Similarly, Huber relates an observation of his own, showing the duration of memory in bees. One autumn he put some honey in a window, which the bees visited in large numbers. During the winter the honey was taken away and the shutters shut. When they were again opened in the spring, the bees returned, although there was no honey in the window."

The obvious criticism is that we have no evidence that the bees that came in the spring were identical with those that came in the preceding autumn, it being possible, and indeed probable, that they visited the window in the second case, as they did in the first, by accident.

The facts which we have already published with regard to the recollection of the properties of glass by hornets ‡ suggest, but scarcely establish, a memory of ten or twelve days' duration. Sir John Lubbock's observations demonstrate that bees remember for at least one day a locality in which they have found honey, but we recall no experiment, not open to serious objections, that tends to prove for ants, bees, or wasps a

* Animal Intelligence, p. 154.

† L. c., p. 155.

‡ Proceedings of the Natural History Society of Wisconsin, pp. 121-122.

duration of memory greater than twenty-four hours. The small number of published facts on this subject led us to make an attempt, during the past summer, to obtain some definite data as to the duration of memory in wasps. With this end in view, on August 18, we took from a nest of *Vespa maculata* forty-three wasps, imprisoning them in a large wire cage, and feeding them with apples. We kept them until August 20. Unfortunately, all died but seven. We marked these by a cut on the right upper wing, and set them free at a distance of thirty yards from the nest. They flew in various directions.

On August 22 we took forty wasps from the nest. These we carefully protected from cold at night. We fed them on apples and apple jelly. Owing, probably, to the better care, they kept strong and energetic.

On August 25 we liberated seventeen, marked by a cut on the left upper wing, thirty-five yards from the nest. The majority of these flew toward the nest. A few settled on the ground.

On August 26 we liberated thirteen, with both upper wings cut, thirty-five yards from the nest. They seemed to be in fairly good condition, and flew in various directions, several of them settling near us on the ground.

On August 27 we took seventy wasps from the nest, and gave them every care and attention, intending to keep them out for five or six days. They died in such numbers, however, that on August 29 we took the survivors, eight in number, and, after marking them with a V cut on one wing, set them free at a distance of two hundred and sixteen yards from the nest. Most of these settled near by. A few flew toward the nest.

Having stopped the entrance on the evening of August 29, on the morning of the 30th we poured a solution of cyanide of potassium into the nest, killing all the inhabitants. We then examined the dead wasps, one by one, to determinine how many of those that we had marked and liberated had returned to the nest. The result was as follows:

Of seven which had been retained fifty hours and were liberated thirty yards from the nest, we found five. Of seventeen which had been retained seventy-two hours and were liberated thirty-five yards from the nest, we found eleven. Of thirteen which had been retained ninety-six hours and were liberated thirty-five yards from the nest, we found six. Of eight which had been retained forty-nine hours and were liberated two hundred and sixteen yards from the nest, we found none. It thus appears that wasps remember the locality of their nests for ninety-six hours.

We had hoped to collect a much larger store of facts upon this subject, but were prevented from doing so by the difficulty of keeping the wasps alive after we had taken them from the nest, and by a lack of material to work upon. We were able to find only one wasp nest during the entire summer, although in the summer of the year before we had found thirty-three nests in the same neighborhood.

Our strictures upon the observations of others may seem hypercritical, but when it is remembered that the only warrant for making any inference whatever is based upon the supposition that a similarity in the actions of insects to those of man, under a given set of circumstances, is the result of a similarity in their mental processes, it will seem scarcely possible to be too guarded in drawing conclusions.—*G. W. and E. G. Peckham, in Amer. Naturalist.*

A NEW ALKALOID.*

By R. G. ECCLES, M.D.

THIS is an age of new remedies. Materia medica is constantly extending its bounds. The additions are both useful and useless, but the inexorable law of the survival of the fittest weeds out the worthless and preserves the worthy here as in other lines of progressive development.

I have the honor to present to you this afternoon a new member of that potent class of therapeutic agents known as alkaloids. The shrub within whose seeds I discovered this was, during the late civil war, used in decoction of roots, leaves, and bark by the confederate soldiers for the cure of intermittent fever and, as claimed, with success. It is still used in domestic practice by the natives of the region where it grows. A fluid extract of an allied species is already upon the market, so that somewhere in the country it is being prescribed for some purpose. If in its crude form it has proved of advantage, this new concentrated form should be still more efficient. The seeds contain nearly two per cent. of this alkaloid and a smaller amount of probably two others. The odor of the volatile one of these last is distinctly that of pyridine, an alkaloid of tobacco, and as it is unlikely that two should exist having the same smell, we may at present assume it as probably such.

The second fixed one was procured by percolation with very dilute sulphuric acid after exhaustion with strong alcohol, and, unlike the first, appears to be soluble in and perhaps destroyed by ammonia.

Solution of caustic soda had to be used in its extraction. The seeds are highly charged with a bland, sweet oil, that could readily be substituted for the product of the olive, and as they contain eighteen per cent. it is not at all improbable that it should become an article of commercial importance. Over one-sixth of the total weight of the seed is oil.

My attention was first called to this subject at the December meeting of the Torrey Club, by the reading of a paper by Mr. E. E. Sterns, a New York botanist, on the alleged poisonous properties of the seeds of a plant sent him for identification from the Cumberland Mountains, of Tennessee, where they were locally known as "bubby." He identified them as those of Calycanthus glaucus, Wildenow. The shrub is known in various sections of the South as Carolina allspice, Florida allspice, and sweet scented shrub. I took some of the exhibited fruit home for chemical examination, and subsequently received an additional small supply of the seed by mail from Mr. Sterns.

These so-called "bubby seeds" are declared to be fatal to cattle and sheep that eat them while browsing in the woods. After chewing down a head or two of the dry fruit, they act as if drunk or insane, and finally die. One gentleman reports the loss of a sheep last month in this manner. On dissecting it, he found a large number of partly digested seeds in its stomach.

* Read before the Kings County Pharmaceutical Society, Feb. 14, 1888.

It is now highly probable that the country people are right in considering them poisonous, although botanists for a century or more have considered them innocuous. Their starch, albumen, and oil would render them excellent fattening food for animals, but for the poisonous constituent, and it is likely that the after taste of slight sweetness lures hungry cattle to feed upon them in spite of the bitter.

The fruit is about the size and shape of a pear, but contains no pulp, being merely a dry, brittle shell within which twenty or more large dark brown achenia are found. As they are loose it could be used for a rattle box for a child. The achenia are about the size and shape of those from a large sunflower, but shorter in proportion to their length, and rounder at the ends. For a long time Calycanthus Florida, an allied species, has been prized as a garden shrub, but no one has ever thought of seeking for an alkaloid in the seeds of any of them. The leaves, bark, and flowers of all are well charged with an essential oil that makes them merit the title "sweet scented shrub." The flowers are of a purplish brown or chocolate color, and when squeezed emit an odor very much like that from strawberries. They are quite large, being nearly two inches in diameter. The shrub is from six to eight feet high, and grows abundantly in the shaded woods that flank the mountains of Tennessee, North Carolina, and Georgia. The leaves grow in pairs upon the stem, each being directly opposite the other. They are dark green and roughish on the upper surface, but quite smooth beneath, and no serration or indentation of any kind occurs along the edges. The genus Calycanthus has three species in the southeastern part of the United States and one in California. The three Atlantic coast ones are by some botanists considered mere varieties of a single species, so near akin are they. Other species are found in China and Japan. The widely separated stations thus occupied favor the opinion first advanced by Dr. Asa Gray that the Eastern Atlantic and the Eastern Asiatic flora had a common origin at the time the north frigid zone had a temperate climate. The name proposed for the new alkaloid is calycanthine, after the name of the genus of plants from which it is derived. Should it prove efficient in the cure of intermittent fever, it will be an economical remedy, as the dose will necessarily be small, and the price should certainly be low when there is so large a proportion present in the seed.

It has not yet been put to any physiological tests of importance. On one trial with two of the seeds it was found that the pulse had risen fifteen beats per minute three hours after eating them. With most alkaloids there is a dearth of tests for identification, but fortunately this is not the case with calycanthine. When brought in contact with strong sulphuric acid it becomes yellow. If a little strong hydrochloric acid is applied to the dry alkaloid or its salt, a pale canary yellow first appears, which gradually passes into a beautiful orange. On touching it with strong nitric acid there is immediately developed an olive green color. Combining strong nitric acid and strong sulphuric acid in about equal proportions, and touching it with the same, we at once secure a very dark green, which on dilution becomes a handsome grass green. With strong sulphuric acid and test solution of bichromate of potash, successively applied, there is brought forth a bright rose red. When strong sulphuric acid and sugar are together brought in contact with it, we secure a lovely pink red.

NOTE.—Since the above report was made of calycanthine, the writer has discovered the presence of an alkaloid in Cascara sagrada. The quantity present is small, and although several eminent chemists have been at work upon the bark of this plant for some months past, it has eluded them.—*Brooklyn Medical Journal.*

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